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ATTACHMENT A

S-415-23

STATEMENT OF WORK

FOR

THE GEOSTATIONARY OPERATIONAL ENVIRONMENTAL SATELLITE

GOES-N,O,P,Q

AUGUST 26, 1997

NASA/GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND 20771

GEOSTATIONARY OPERATIONAL ENVIRONMENTAL SATELLITE

GOES-N,O,P,Q

STATEMENT OF WORK

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GEOSTATIONARY OPERATIONAL ENVIRONMENTAL SATELLITE

GOES-N,O,P,Q

STATEMENT OF WORK

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S-415-23 GOES N-Q Statement of Work

I INTRODUCTION

NASA is participating with the DOC/NOAA in a multi-satellite program to provide continuous monitoring of earth and space environment parameters. The monitored parameters will provide data for weather prediction models and provide severe weather warning data. The program is termed Geostationary Operational Environmental Satellite (GOES) and is accomplished using two National Oceanic and Atmospheric Administration (NOAA) geostationary satellites stationed at two longitudes over the equator. The Goddard Space Flight Center (GSFC) GOES project office has been given responsibility for procuring the necessary hardware and support services to meet the mission requirements as specified herein.

This Statement of Work (SOW) defines the contractor's efforts required to implement the GOES N,O,P,Q (N-Q) program. These spacecraft will be used to continue and enhance the present function of the existing GOES I-M spacecraft. The main purpose of this program is to design, develop, integrate, test, deliver on-orbit to NASA , and support on-orbit operations of two (with options for one plus one) GOES spacecraft. The GOES N-Q spacecraft shall provide stable platforms to support:

- the Imager and Sounder instruments in making measurements of the Earth's atmosphere, its surface, and cloud cover,
- the Solar X-ray Imager (SXI) and Space Environment Monitor (SEM) instruments in making measurements of the solar and geosynchronous space environments.

In addition, the spacecraft shall support:

- collection and distribution of data collection platform reports,
- rebroadcasting processed sensor data through the processed data relay (PDR), weather facsimile (WEFAX), and Emergency Managers Weather Information Network (EMWIN), and
- receive and relay to the ground search and rescue (SAR) emergency signals.

The government furnished equipment (GFE) instruments for GOES N-Q are: the Imager, the Sounder, and the Solar X-Ray Imager (SXI). The GOES N-Q mission may also include a Lightning Mapper (LM) instrument, an Advanced Imager in place of the Imager, and/or an Advanced Sounder in place of the Sounder.

The GOES N-Q spacecraft shall be launched by the spacecraft contractor-provided launch vehicle into geostationary transfer orbit and subsequently inserted into geostationary orbit. The performance and interface requirements for the GOES N-Q Program are defined in the Performance Specification S-415-22, the Interface Control Document for the GOES-N,O,P,Q Imager (8175726), the Interface Control Document for the GOES-N,O,P,Q Sounder (8175751), and the Solar X-ray Imager (SXI) Interface Control Document (S-415-25).

II SCOPE

The spacecraft contractor shall furnish the necessary personnel, facilities, services, and materials to design, fabricate, integrate, test, deliver on-orbit to NASA, and support on-orbit operations for all of the GOES N-Q spacecraft developed under this contract. This work shall be performed in accordance with the requirements of this document and all attachments to the contract.

In accomplishing the development and delivery of the GOES N-Q spacecraft, the spacecraft contractor shall perform the following:

1. Provide the spacecraft bus and the Space Environment Monitor (SEM) instruments for each of the GOES spacecraft.
2. Receive the GFE instruments and related ground support equipment (GSE), then integrate them with the spacecraft bus and perform spacecraft level testing.
3. Provide all required spacecraft mechanical and electrical GSE.
4. Provide a spacecraft emulator and INR Performance Evaluation System
5. Deliver and support integration, verification, and maintenance of ground system hardware and software.
6. Design and support integration and verification of any modifications or replacements to NOAA ground system hardware and software.
7. Support combined spacecraft and ground system testing, and GOES end-to-end testing before launch.
8 Provide all services associated with the launch vehicle procurement, launch base processing facility, launch base coordination and safety, spacecraft/launch vehicle integration and checkout, and launch.
9. Provide all services associated with flight operations from the launch vehicle/spacecraft separation through spacecraft positioning in geostationary checkout orbit.
10. Support all services associated with the on-orbit spacecraft checkout and support associated with instrument and INR checkout.
11. Provide spacecraft operator and engineering training for on-orbit operation.
12. Provide on-orbit engineering support for the Spacecraft Support Ground System (SSGS) and each spacecraft.

The spacecraft contractor is required to deliver the GOES N-Q spacecraft fully compatible and operational with NOAA Ground Systems: the Satellite Operations Control Center (SOCC), Suitland, MD; the Wallops Command and Data Acquisition Station (WCDAS), Wallops, VA; a backup CDAS; and the Space Environment Center (SEC), Boulder, CO. Changes to the existing ground systems to accommodate upgraded or additional capabilities are permitted as defined in section 3.5. The contractor's delivered spacecraft and associated efforts shall meet all requirements of the GOES N-Q Performance Specification S-415-22.

III APPLICABLE DOCUMENTATION

The documents listed in this section apply directly to the performance of the GOES N-Q Contract. These documents establish detailed specifications, requirements, and interface information necessary for the performance of the contract. Unless otherwise specified, the document version in effect at the time the contract is executed shall apply.

S-415-22	Performance Specification For the GOES-N,O,P,Q
S-415-26	Contract Documents Requirements List For the GOES-N,O,P,Q Program
S-415-27	Program Review Requirements For the GOES-N,O,P,Q Program
8175726	Interface Control Document For the GOES-N,O,P,Q Imager
8175751	Interface Control Document For the GOES-N,O,P,Q Sounder
S-415-25	Solar X-ray Imager (SXI) Interface Control Document
S-415-28	Fallout Plate Installation and Removal Procedure and Fairing Tapelift Sampling Plan
S-415-29	Launch Site Purge Plan for the Geostationary Operational Environmental Spacecraft (Satellite)

IV WORK TO BE PERFORMED

This section, along with the CDRL S-415-26, describes the specific work to be accomplished by the GOES N-Q spacecraft contractor. The spacecraft contractor shall provide all facilities, services, materials, and personnel necessary for the successful and on-time implementation of all of the efforts required by the contract.

1.0 PROGRAM MANAGEMENT

The spacecraft contractor shall provide a program management function that is responsible for the control of the GOES N-Q effort. The spacecraft contractor shall provide for, and facilitate the use of, this program management function to provide NASA reporting and real-time insight into the technical and programmatic performance and status of all of the spacecraft contractor's responsibilities and activities under the contract. The spacecraft contractor shall provide all facilities, services, and personnel necessary to maintain management control over the development of the entire GOES N-Q program and assure that the contract requirements are fully met.

The spacecraft contractor shall conduct bi-monthly and quarterly program status reviews to NASA in accordance with CDRL PM-1.1-01. These reviews shall be rotated between the spacecraft contractor's facility (HSC), GFE instrument contractor plants and GSFC. The spacecraft contractor shall also assist in preparing material and/or supporting additional reviews, audits, and meetings that will occur during the contract.

1.1 Program Reviews

The program review requirements for the GOES N-Q Program shall be as defined in the Program Review Requirements document for the GOES N-Q Program (PRR), S-415-27. Indicated in Table 1.1 are the review milestone activities that will be closely monitored by GSFC. No more than four NASA representatives shall participate as chairpersons for each of the reviews listed in Table 1.1.

The guidelines for preparing these reviews are provided in the referenced CDRL items. The PRR defines the criteria for successful completion of these reviews.

The spacecraft contractor shall also conduct peer reviews and working group meetings at the spacecraft and launch vehicle component and subsystem levels as defined in the PRR.

Those reviews where NASA attendance is indicated only for the GOES-N spacecraft assume no changes to the spacecraft, SSGS, GSE, and launch vehicle are required for the follow-on spacecraft. However, if form, fit, function, component, vendor, method of assembly, and/or integration and test approach are modified or changed, then NASA shall be notified and a review scheduled. The reviews shall encompass all affected subsystems and conform to the requirements delineated in the remainder of this SOW, the PRR, and the CDRL.

Table 1.1
Program Reviews

Spacecraft Reviews	**CDRL Reference**	**PRR Reference**	**Applicable Spacecraft [3]**
System Concept Review (SCR)	SE-2.1-01	Para. 1.3.2	GOES N
Preliminary Design Review (PDR) [2]	SE-2.1-02	Para. 1.3.3	GOES N
Critical Design Review (CDR) [2]	SE-2.1-03	Para. 1.3.4	GOES N
Mission Operations Review (MOR)	SE-2.1-04	Para. 1.3.5	GOES N-Q
Pre-Environmental Review (PER)	SE-2.1-05	Para. 1.3.6	GOES N-Q
Pre-Shipment Review (PSR)	SE-2.1-06	Para. 1.3.7	GOES N-Q
Flight Operations Review (FOR)	SE-2.1-07	Para. 1.3.8	GOES N-Q
Spacecraft Launch Readiness Review (LRR)	SE-2.1-08	Para. 1.3.9	GOES N-Q
Engineering Handover Review (EHR)	OPS-3.6.3-01	Para.1.3.10	GOES N-Q
LOR Data Review (LDR)	OPS-3.6.3-02	Para.1.3.11	GOES N-Q
Software Reviews	**CDRL Reference**	**PRR Reference**	**Applicable Spacecraft**
Software Concept Review (SWCR)		Para. 1.4.2	
Software Requirements Review (SWRR)		Para. 1.4.3	
Software Preliminary Design Review (SWPDR)		Para. 1.4.4	
Software Critical Design Review (SWCDR)		Para. 1.4.5	
Software Test Readiness Review (SWTRR)		Para.1.4.6	
Software Acceptance Review (SWAR)		Para. 1.4.7	
Spacecraft Support Ground System Reviews	**CDRL Reference**	**PRR Reference**	**Applicable Spacecraft [3]**
System Concept Review (SCR)	Note 1	Para. 1.5.2.1	GOES N
Preliminary Design Review (PDR)	Note 1	Para. 1.5.2.2	GOES N
Critical Design Review (CDR)	Note 1	Para. 1.5.2.3	GOES N
Pre-Shipment Review (PSR)	Note 1	Para. 1.5.2.4	GOES N
Final Acceptance Review	Note 1	Para. 1.5.2.5	GOES N
Spacecraft Emulator Reviews and INR Performance Evaluation System	**CDRL Reference**	**PRR Reference**	**Applicable Spacecraft**
System Concept Review (SCR)		Para.1.6	

Preliminary Design Review (PDR)		Para.1.6	
Critical Design Review (CDR)		Para.1.6	
Final Acceptance Review		Para.1.6	
Electronic Data Distribution System	**CDRL Reference**	**PRR Reference**	**Applicable Spacecraft**
Critical Design Review (CDR)		Para. 1.7	GOES N
Launch Reviews	**CDRL Reference**	**PRR Reference**	**Applicable Spacecraft [3]**
Mission Integration Program Kickoff Review	LV-3.8-07	Para. 1.8.2	GOES N-Q
Final Loads Verification Review	LV-3.8-17	Para. 1.8.3	GOES N
Launch Vehicle Requirements Review (LVRR)	LV-3.8-09	Para. 1.8.4	GOES N-Q
Launch Vehicle Pre-Installation Review (Major Components, Only))	LV-3.8-16	Para. 1.8.5	GOES N-Q
Launch Vehicle Design Certification Review (LVDCR)	LV-3.8-05	Para. 1.8.6	GOES N
Launch Vehicle Pre-Ship Review	LV-3.8-20	Para. 1.8.7	GOES N-Q
Booster On Stand Review	LV-3.8-04	Para. 1.8.8	GOES N-Q
Launch Vehicle Pre-Payload Mate Review	LV-3.8-24	Para. 1.8.9	GOES N-Q
Launch Vehicle Mission Peculiar/Mission Unique PDR	LV-3.8-11	Para. 1.8.10	GOES N
Launch Vehicle Mission Peculiar/Mission Unique CDR	LV-3.8-12	Para. 1.8.11	GOES N
Launch Vehicle Component/System Design Review (Major Mods, Only)	LV-3.8-10	Para. 1.8.12	GOES N-Q
External Independent Readiness Review (EIRR)	PM-1.3-06	Para.1.8.13	GOES N-Q
Senior NASA Management Mission Readiness Review	LV-3.8-23	Para. 1.8.14	GOES N-Q
Launch Readiness Review	LV-3.8-25	Para. 1.8.15	GOES N-Q

Note 1: Each of the SSGS reviews are required for CDRL items GND-3.5.2-01 through GND-3.5.2-06.
Note 2: Reviews for GOES O, P, Q shall be conducted if required.
Note 3: The Applicable Spacecraft could apply to any or all of the spacecraft.

1.2 Resource Management

The spacecraft contractor shall establish, implement, and maintain a comprehensive resource management system for planning, authorizing, and controlling the total resources effort for each task and

for providing timely and adequate visibility into manpower and schedule performance. The system shall be consistent with the spacecraft contractor's standards.

The spacecraft contractor shall provide facilities required for component, subsystem, and spacecraft development and testing, such as: clean rooms, thermal vacuum chambers, thermal cycle chambers, vibration facilities, and spacecraft storage facilities.

The spacecraft contractor shall establish, implement, and maintain an integrated scheduling system consistent with their corporate procedures and documented in a schedule management plan. The spacecraft contractor shall provide a master program phasing schedule, spacecraft schedules, and detailed subsystem schedules in accordance with CDRL PM-1.1-02.

The spacecraft contractor shall provide the necessary resources for monitoring, controlling, executing, and administering the GOES N-Q contract and subcontracts to ensure compliance with all contractual requirements.

1.3 Documentation Management

The spacecraft contractor shall establish, implement, and maintain a configuration management (CM) system to be documented in a hardware/software CM plan in accordance with CDRL PM-1.3-04 and consistent with ANSI/ASQC 9001-1994 or equivalent company practice. The spacecraft contractor's CM approach shall be able to control multiple spacecraft configurations based on the GFE instrument complement.

The spacecraft contractor shall prepare and provide the following configuration control documentation:

1. Configuration Control Board (CCB) data packages as described in CDRL PM-1.3-01.
2. Engineering Change Proposals (ECPs), deviations, and waivers as described in CDRL PM-1.3-02.
3. Engineering drawings and change notices as described in CDRL PM-1.3-03.
4. The Configuration Item Identification List (CIIL) and the Computer Software Configuration Items (CSCIs) in accordance with CDRL PM-1.3-05.

The spacecraft contractor shall prepare and provide all documentation in accordance with the CDRL for the GOES N-Q Program, S-415-26.

1.3.1 Electronic Data Distribution System (EDDS)

The spacecraft contractor shall provide an EDDS capable of providing government and authorized contractor personnel access to CDRLs, spacecraft level (including integrated instrument) raw test data, and other documentation. The system shall be operational within six months after contract award, and shall incorporate the minimum features described below:

1. Password protected so that only authorized personnel can access document items.
2. Implemented on a Unix or Windows NT operating system platform for support software availability, ease of upgrade, and security features.
3. Provide virus and macro virus protection as well as back-up capabilities.

4. Reliable or redundant enough to provide an operational availability of 0.95 (i.e., hardware/software shall be available 95% of the time).
5. Provide access to documentation in Adobe Portable Documentation Format (PDF).
6. Provide a search engine for document access.
7. Accessible via Internet FTP, hypertext transfer protocol (HTTP) or equivalent.
8. Permit documents to be downloaded to local machines for viewing and printing.
9. Allow documents to be viewed (browsed) without being downloaded.
10. Provide a shareware PDF viewer for download.
11. Provide any necessary EDDS hardware/software needed for use at GSFC.

The spacecraft contractor shall provide a Critical Design Review (CDR) as defined in section 1.1, and an Acceptance Test plan and procedure for the EDDS. In addition, the spacecraft contractor shall provide the necessary documentation that can be used to instruct data users on the proper use of the system.

1.3.1.1 EDDS Implementation Plan

Implementation of the EDDS plan shall be as follows:

1. During the initial six months of the contract, while the EDDS is being configured, distribution of documents shall be accomplished in a manner mutually acceptable to GSFC and the spacecraft contractor.
2. Following the development and checkout of the EDDS, the spacecraft contractor shall be responsible for the electronic delivery of all CDRL items that are designated for that form of delivery in the CDRL. All CDRL items delivered during the initial **six**-month period described in item 1 above shall be incorporated in the EDDS at the beginning of this implementation phase.

1.3.2 Internal Correspondence

The spacecraft contractor shall provide all GOES-relevant technical internal correspondence. The correspondence can be informal to preserve timeliness. NASA shall have access to this correspondence on a timely basis via hard copy or the EDDS defined in section 1.3.1.

1.3.3 GOES Data Books

The spacecraft contractor shall provide up-to-date GOES Data Books prior to each spacecraft launch in accordance with CDRL PM-1.1-03.

1.4 NASA Resident Office Support

The spacecraft contractor shall provide office space, furniture, copier(s), facsimile machine(s), and phones at the spacecraft contractor's facility through launch of the last spacecraft for six NASA residents and six visiting representatives. The spacecraft contractor shall provide office space, furniture, copier(s), facsimile machine(s), and phones for an additional ten (10) visiting NASA and/or GFE instrument contractor representatives during instrument and instrument GSE integration and test activities.

1.5 Special Studies

The spacecraft contractor shall perform task assignments relating to the development, implementation, characterization, and operation of the GOES mission requirements, as authorized by NASA and in accordance with contract clause C.2. Each task will be initiated by written direction from the NASA contracting officer. NASA will coordinate with the spacecraft contractor to define each task in detail, and establish manpower ceilings and performance schedules.

2.0 SYSTEMS ENGINEERING

The spacecraft contractor shall perform all efforts to ensure that the GOES N-Q program and its implementation meet or exceed all requirements and specifications listed in Section III of this SOW. The systems engineering effort shall encompass all phases of the GOES N-Q program, and shall include modifications to the NOAA ground system required to support the GOES N-Q program.

The systems engineering effort shall comprise analyses of technical requirements, allocation of derived requirements, definition and maintenance of all interfaces, verification of all defined and derived requirements, risk management, and tradeoff analyses. The systems engineering effort shall be on-going through all stages of the GOES N-Q program, including the allocation of the system performance specification, design, development, fabrication, qualification and acceptance testing, launch operations, launch, post launch checkout, on-orbit anomaly resolution, integration into the operational GOES system, and support to system operations.

2.1 Systems Engineering Management

The spacecraft contractor shall perform a fully integrated systems engineering management effort. This support shall include but not be limited to the following activities:

1. Providing technical direction and oversight throughout all phases of the program.
2. Supporting all peer reviews, program reviews, and program status reviews as defined in section 1.1. The support shall include responsibility for the preparation of responses to all action items assigned to the spacecraft contractor during the reviews.
3. Attending and supporting instrument reviews at the GFE instrument contractors' facilities (assume 1 review per quarter).
4. Performing all necessary system studies and trades and risk assessments necessary to develop the spacecraft design.

2.2 Interface Definition, Verification and Control

Using the results of the analyses and allocations of technical parameters performed in support of the efforts described in section 2.3, the spacecraft contractor shall specify all interfaces, including INR and GFE instrument interfaces not explicitly defined by NASA documents. In the area of INR, this includes interfaces related to ground system-to-spacecraft, spacecraft-to-subsystem, subsystem-to-subsystem, and subsystem-to-instrument. These interfaces shall then be defined, verified by the spacecraft contractor, and controlled for the duration of the contract. The spacecraft contractor shall support all activities

assuring the proper functioning of those items under the spacecraft contractor's GOES contract responsibilities.

A system performance verification matrix shall be prepared and maintained to show each GOES N-Q Performance Specification S-415-22 requirement, the method of compliance, applicable procedure references, results, report reference numbers, etc. This matrix shall be included in the spacecraft system review data packages showing the current verification status.

2.2.1 GFE Instrument Interfaces

The GOES N-Q instruments to be GFE are the Imager, Sounder, and SXI. The spacecraft contractor shall be notified, via the contract changes clause, when NASA chooses to manifest alternate or additional instruments.

The spacecraft contractor shall perform systems engineering and analysis in support of designing, documenting, and implementing all interfaces between the spacecraft subsystems and GFE instruments, and spacecraft GSE-to-GFE instrument GSE. This support shall include, but not be limited to the following:

1. Documenting in the requirements traceability matrix, CDRL SE-2.3-01, how the spacecraft requirements defined in the GFE ICDs will be verified.
2. Addressing GFE instrument accommodations as part of each spacecraft design and operations review.
3. Documenting the GFE instrument interface-relevant aspects of the spacecraft design and providing this documentation as defined in CDRL SE-2.2-01.
4. Maintaining CM control of the GFE instrument ICDs.
5. Documenting the GFE instrument GSE interface-relevant aspects of the spacecraft GSE and providing this documentation as defined in CDRL SE-2.2-01.
6. Maintaining CM control of the GFE instrument GSE to spacecraft GSE ICDs.
7. Identifying cognizant engineer(s) responsible for the GFE instrument interfaces.
8. Providing technical support for interface design, documentation, and verification.
9. Performing mechanical, thermal, power, contamination, radiation shielding, and other analyses as necessary to ensure spacecraft to GFE instrument compatibility.
10. Developing and documenting in the performance verification plan, CDRL SE-2.4-01, how the instrument-spacecraft system level requirements such as INR and BER performance shall be verified. The role of the GFE instrument contractor's personnel or test equipment (if any) in verifying these requirements shall be coordinated with those contractors and approved by NASA.
11. Defining and documenting changes or additions (if any) to the GFE instrument-level test program required to verify interface or system level requirements prior to instrument integration. Changes and additions shall be coordinated with the instrument contractors and approved by NASA.

2.2.2 NOAA Ground System

The spacecraft contractor shall perform systems engineering and analysis in support of spacecraft and instrument to NOAA ground system interface design, documentation, and implementation. This support shall include, but not be limited to, the following:

1. Generating and maintaining CM control of the SSGS Interface Specification CDRL GND-3.5.2-05.
2. Generating the necessary modifications to existing NOAA ground system documentation.
3. Identifying cognizant engineer(s) responsible for the NOAA ground system interfaces.
4. Performing the analyses necessary to ensure spacecraft to ground system compatibility, and intra-SSGS compatibility.
5. Developing and documenting in the SSGS design and implementation plans, CDRLs GND-3.5.2-01 through GND-3.5.2-06, how the GOES N-Q ground system requirements shall be verified. The use of NOAA ground system personnel or equipment in verifying these requirements shall be coordinated with and approved by NASA.

2.3 Requirements Analyses and Allocations

2.3.1 Requirements Analyses

The spacecraft contractor shall conduct complete analyses and simulations in support of technical requirements compliance demonstrations to fully establish, define, maintain, and control budget allocations for all required performance and design parameters. Budget allocations shall include, but not be limited to, mass properties, power, radio frequency transmission channels, alignment, INR, contamination, on-board processor resources, and propellent capacities. These tasks include, but are not limited to, the following:

1. Developing and maintaining a GOES N-Q spacecraft design specification (CDRL SE-2.4-03) for spacecraft systems, subsystems, and components. The component and subsystem design specifications shall be prepared in accordance with CDRL SDA-3.2.1-01.
2. Developing and maintaining SSGS design and implementation in accordance with CDRLs GND-3.5.2-1 through GND-3.5.2-06.
3. Developing and verifying the GOES N-Q operations concepts and perform the launch-to-orbit and on-orbit mission analyses.
4. Conducting the analyses required to confirm the integrity of the GOES N-Q design to ensure the performance requirements of the applicable specifications will be met over the spacecraft operational design life.
5. Conducting the analyses required to verify that the spacecraft provides the interface and environment necessary for the GFE instruments to meet their functional and performance requirements.
6. Developing a requirements traceability matrix (CDRL SE-2.3-01) which describes how each spacecraft requirement will be verified.
7. Preparing the spacecraft mass properties reports as described in CDRL SM-3.1.1-02.
8. Preparing the spacecraft power profile reports as described in CDRL SM-3.1.1-03.
9. Prepare and implement an ESD/SEU Prevention Plan in accordance with CDRL SE-2.5-01.

2.3.1.1 INR Error Allocation Budgets

The spacecraft contractor shall establish and maintain separate Imager and Sounder INR error allocation budgets over the duration of the contract. These shall be kept updated to reflect the results of analyses and tests in accordance with CDRL SDA-3.2.16-01.

For each INR budget item, the approach for determining and compensating the error (i.e., using the control system, repointing the mirror, mix of the control system and mirror, etc.) shall be provided and updated as required. Of particular interest are the approaches for compensating rapidly changing errors to ensure these errors do not exceed the allocation for the servo input signal.

For each spacecraft, error allocation budgets shall be provided for normal and stationkeeping periods, and any other unique periods where the performance will be or may be different from the expected normal operational performance. The allocation budgets also shall include the effects of sun declinations of ±8.7, ±23, and zero degrees (equinox).

2.3.2 Allocations

The spacecraft contractor shall define the number and hierarchy (sub-modes) of the various spacecraft operating modes (e.g., the normal operations mode), if any.

2.4 Design and Performance Verification Plans and Analyses

The spacecraft contractor shall develop and maintain all necessary plans and procedures to verify that the GOES N-Q spacecraft meets all requirements described in the GOES N-Q Performance Specification S-415-22 and GFE Instrument ICDs. The spacecraft contractor shall also perform and document all analyses of the data and information from the design, development, qualification testing, acceptance testing, compatibility testing, and on-orbit testing of the spacecraft contractor's hardware and software which are required to ensure that the GOES N-Q program will meet its specifications and objectives. These tasks include, but are not limited to the following:

1. Preparing and maintaining the performance verification plan (CDRL SE-2.4-01) for use at the component, subsystem, and spacecraft level of assembly, including instrument integration and interface verification.
2. Preparing and maintaining the GOES N-Q performance verification specification as defined in CDRL SE-2.4-02.
3. Preparing and maintaining verification test procedures for use at the component, subsystem, and spacecraft level of assembly, including instrument integration and interface verification. The spacecraft test procedure requirements are described in CDRL I&T-3.4.4-01, the launch site test procedures are described in CDRL I&T-3.4.6-03, and the component/subsystem test procedures are described in CDRL SFAT-3.3.1-01.
4. Providing the effort required for data reduction and analysis of test results at the component and subsystem levels of assembly during spacecraft integration and environmental testing, and during verification of GFE instruments interfaces.

5. Providing the necessary effort for data reduction and analysis during ground system compatibility testing and during on-orbit testing.
6. Preparing verification test reports following the completion of each environmental test and test activities described in CDRL I&T-3.4.4-03.
7. Preparing documentation and providing necessary support for reviews defined in section 1.1.
8. Preparing an electromagnetic compatibility/electromagnetic interference (EMC/EMI) plan as required in CDRL SE-2.5-03.
9. Performing systems engineering and analysis in support of GFE instrument contractors' development and execution of instrument tests at the spacecraft level and launch base.
10. Developing the necessary pre-launch plans and procedures to verify that the GOES N-Q INR elements will operate as designed. This will require using the INR Performance Evaluation System (refer to section 3.2.16.1) and a combination of simulated inputs and test results to demonstrate that the on-orbit performance will achieve the specification requirements.
11. Preparing a magnetic control plan in accordance with CDRL SDA-3.2.14-02.
12. Preparing a radiation shielding and dose analysis report as defined in CDRL SE-2.5-06.
13. Performing a fields of view analysis as described in CDRL SE-2.5-02.
14. Preparing a debris generation analysis report as defined in CDRL SE-2.5-05.

2.5 Spacecraft System Engineering

The spacecraft contractor shall provide a systems engineering function to support the functional design and development of the spacecraft and incorporation of the instrument systems. This function shall address the total spacecraft design including performance margins and design approaches to assure achievement of the required spacecraft life, spacecraft operations concept, design integrity, failure modes, intra-system and inter-system compatibility, reliability and maintainability, producibility, safety, survivability, training, and testability. In addition, this function shall oversee all of the work associated with the development of the spacecraft.

2.5.1 Schematics, Block Diagrams and Drawings

The spacecraft contractor shall provide the schematics, block diagrams, and drawings that are described in CDRL SE-2.5-04.

3.0 GOES SPACECRAFT

The spacecraft contractor shall provide all necessary personnel, facilities, services, and materials to design, fabricate, integrate, test, launch, deliver to checkout orbit, and functionally test the GOES N-Q spacecraft. The government will provide the operations center from which spacecraft launch, orbit raising, and checkout shall be conducted.

3.1 Spacecraft Management

The spacecraft contractor shall perform the necessary direct management functions and provide the management structure to plan, direct, and integrate all requirements of this SOW, through compliance with the schedule, technical, and resource requirements of this contract.

3.1.1 Management

The spacecraft contractor shall provide spacecraft management to ensure that the schedule, technical, and resource requirements for the GOES N-Q program are fully met.

3.1.2 Travel Costs

The spacecraft contractor shall be responsible for the management of all travel expenses (air fare, car rental, living expenses, etc.).

3.1.3 Photographs and Video Tapes

The spacecraft contractor shall provide photographs and video tapes for each spacecraft as described in CDRL SM-3.1-01.

3.2 Subsystem Design and Analysis

The spacecraft contractor shall furnish all necessary personnel, facilities, services, and materials to support subsystem design and analysis, and accommodation of the GFE instruments for GOES N-Q. The spacecraft contractor shall prepare and provide subsystem and component design review data packages in accordance with CDRL SDA-3.2.1-02.

3.2.1 Management

The spacecraft contractor shall provide the management functions necessary to support efforts associated with the subsystem design and analysis activities for GOES N-Q.

3.2.2 Structures

The spacecraft contractor shall provide all personnel, facilities, services, and materials necessary to develop, verify, and maintain a design for the GOES N-Q structures subsystem. This includes the main body, appendage devices, and spacecraft-to-launch vehicle separation system.

The spacecraft contractor shall provide:

1. A structures subsystem performance analysis report as described in CDRL SDA-3.2.2-01.
2. A structural static and dynamic model and model verification plan in accordance with CDRL SDA-3.2.2-02.
3. A stress analysis report prepared in accordance with CDRL SDA-3.2.2-03.

NASTRAN finite element models (FEM) of the GFE instruments will be supplied by the government for use in designing the spacecraft-instrument interfaces. The spacecraft contractor shall combine the GFE

instrument FEMs of the Imager, Sounder, and SXI with the spacecraft and SEM instrument FEMs to form a combined comprehensive spacecraft-instrument FEM for launch and on-orbit configurations.

3.2.2.1 Structural Model - Launch Configuration

The spacecraft FEM, with instruments represented in a manner consistent with the spacecraft modal survey, shall be correlated to the modal survey test data. For the first two spacecraft lateral modes, orthogonality checks between analytical and test modes shall show a correlation of better than 95%. Cross-orthogonality shall be no greater than 5%. Frequency correlation for these modes shall be greater than 95%. For all other spacecraft modes to 50 Hz with greater than 5% modal mass, or any other modes to 50 Hz and deemed critical for any components, orthogonality shall be greater than 90% and cross orthogonality shall be less than 10%. Frequency correlation for these modes shall be greater than 90%. Any modifications to the analytical model found necessary to achieve this correlation must be made to the physical model not the modal model, and based on better approximating the real structure. The combined comprehensive spacecraft-instrument FEM shall be used for coupled loads analysis to define design limit loads for spacecraft hardware and components, and to verify that the interface design meets the requirements of the GFE instrument ICDs. The combined FEM results of the coupled loads analysis shall be used in a series of tests and analyses to demonstrate that the flight hardware is qualified for the expected mission environments.

3.2.2.2 Structural Model - On-Orbit Configuration

The on-orbit FEM shall represent the spacecraft with all appendages and instrument covers deployed. This model also shall represent mechanical transfer functions and coupling from all potential disturbances to all jitter-sensitive instruments for the low-level vibrations expected on-orbit. The spacecraft contractor shall substantiate the model accuracy through the use of piece-part correlated subsystem models and the ability to reproduce the results from the dynamic interaction tests. The model shall be created such that the government can easily modify it to simulate all possible solar array angles during operational modes. The combined comprehensive spacecraft-instrument FEM shall be capable of being used throughout the spacecraft development and mission to predict instrument performance and diagnose on-orbit anomalies.

3.2.3 Propulsion

The spacecraft contractor shall provide all personnel, facilities, services, and materials necessary to develop, verify, and maintain a design for the GOES N-Q propulsion subsystem.

The spacecraft contractor shall provide a propulsion subsystem performance analysis report as described in CDRL SDA-3.2.3-01.

3.2.3.1 Computer Model

The spacecraft contractor shall provide the resources to develop and deliver a computer program and supporting documentation that predicts the performance of the propulsion subsystem during on-orbit operations of the GOES N-Q spacecraft. The spacecraft contractor shall also perform the following tasks:

1. Deliver the source-code and documentation (inclusive of background mathematics) for the contractor-owned deterministic computer program for predicting the performance of the propulsion subsystem. The source code and documentation are to be provided in an "as is" condition and will not be subject to GOES software quality review requirements.
2. Deliver the experimental data, which is the acceptance test data, for the thrusters used on the GOES N-Q, and for other thrusters flown on missions similar to the GOES N-Q.
3. Supply existing in-flight results from previous missions that indicate the performance of the spacecraft contractor's propulsion subsystem.
4. Support three consultation meetings at GSFC as it studies the spacecraft contractor's computer model and data, and critique the GSFC design for its computer model.
5. Provide a set of test cases that will be run in the contractor's deterministic computer program to aid GSFC's understanding of that program. These test cases should be designed to show how changes in the thermal environment, such as temperature and pressure variations as might be seen in flight, would effect the thruster performance.

3.2.4 Attitude Control

The spacecraft contractor shall provide all personnel, facilities, services, and materials necessary to develop, verify, and maintain a design for the GOES N-Q attitude control subsystem (ACS). The detailed safe hold mode capability of the attitude control subsystem shall be defined, analyzed, approved by GSFC at the System Concept Review, and documented for the mission operations team. The analyses and tests demonstrating the ACS performance shall be reflected in the INR error allocation budget (section 2.3.1, CDRL SDA-3.2.16-01)

The spacecraft contractor shall provide an attitude control subsystem performance analysis report as described in CDRL SDA-3.2.4-01, and an ACS detailed description as described in CDRL SDA-3.2.4-02.
Add a 256K external PROM module to the baseline GOES-NO PQ Attitude Control Electronics (ACE) configuration.

3.2.5 Thermal Control

The spacecraft contractor shall provide all personnel, facilities, services, and materials necessary to develop, verify, and maintain a design for the GOES N-Q thermal control subsystem. The spacecraft contractor shall provide a thermal control subsystem performance analysis report as described in CDRL SDA-3.2.5-01.

3.2.5.1 Thermal Analytical Models

Detailed TMG format thermal models of the Imager and Sounder and reduced SINDA format thermal models of the SXI and LM, if applicable, will be supplied by the government for use in designing the spacecraft-instrument interfaces. The spacecraft contractor shall combine the GFE models of the

Imager, Sounder, SXI and LM instruments with their analytical nodal models of the spacecraft and SEM instruments to form a combined comprehensive spacecraft-instrument analytical model. This combined comprehensive spacecraft-instrument model shall be correlated with spacecraft level test data and orbital data for the six orbits in section 3.2.5.2 to ±5EC for spacecraft components and ±3EC for GFE instrument components.

The thermal math models shall be prepared in accordance with CDRL SDA-3.2.5-02.

3.2.5.2 Thermal Analyses

The combined comprehensive spacecraft-instrument analytical model shall be used to design the GFE instrument interfaces and for instrument and/or spacecraft BOL and EOL temperature predictions to show compliance with requirements. The spacecraft contractor shall provide temperature predictions from lift-off through transfer orbit, and for the following synchronous orbits:

1. Winter (S = 444 BTU/HRFT²)
2. Summer (S = 414 BTU/HRFT²)
3. Equinox (S = 429 BTU/HRFT²)
4. North 8.7E Sun Declination (S = 423.5 BTU/HRFT²)
5. South 8.7E Sun Declination (S = 435.4 BTU/HRFT²)
6. On-Orbit Storage (S = 414 BTU/HRFT²)

3.2.5.3 Thermal Distortion Model

Thermal distortion models of the GFE Imager and Sounder will be supplied by the government for use in designing the spacecraft-instrument interfaces. The spacecraft contractor shall develop a comprehensive combined spacecraft-Imager/Sounder thermal distortion model for use in the development of the INR subsystem and to show compliance with the INR specifications.

3.2.5.4 GFE Instruments

The spacecraft contractor shall use the combined comprehensive spacecraft-instrument thermal model to design the Imager, Sounder, SXI and LM thermal interfaces and to verify that the predicted Imager and Sounder temperatures compare favorably to the requirements defined in the Imager and Sounder ICDs and the SXI ICD, respectively. The spacecraft contractor shall use the combined comprehensive spacecraft instrument thermal model to verify that the SXI and LM meet all the thermal requirements of their respective ICDs.

3.2.6 Power and Electrical

The spacecraft contractor shall provide all personnel, facilities, services, and materials necessary to develop, verify, and maintain a design for the GOES N-Q power and electrical subsystem. The spacecraft contractor shall provide a power and electrical subsystem performance analysis report as described in CDRL SDA-3.2.6-01.

3.2.7 Ground Support Equipment

The spacecraft contractor shall provide all personnel, facilities, services, and materials necessary to develop, verify, and maintain a design for the GOES N-Q subsystem electrical and mechanical ground support equipment.

3.2.7.1 Automated Test Equipment (ATE) Requirements

The spacecraft contractor shall provide ATE signal paths maximizing calibration accuracy, stability and repeatability for each test phase, from test phase to test phase, and from spacecraft to spacecraft. The ATE shall be configured to ensure measurement accuracy through component and part selection.

3.2.8 Communications

The spacecraft contractor shall provide all personnel, facilities, services, and materials necessary to develop, verify, and maintain a design for the GOES N-Q communication subsystem. The communication subsystem comprises: Sensor Data, PDR and ranging, WEFAX, EMWIN, DCPI, DCPR, SAR, and MDL. The spacecraft contractor shall provide a communications subsystem performance analysis report as described in CDRL SDA-3.2.8-01.

The spacecraft contractor shall develop and maintain the link calculations for each of the communications channels (See CDRL SDA-3.2.8-01). The initial link calculations shall be provided at the PDR with an update at CDR, and six months prior to each launch.

3.2.8.1 Computer Simulation

The spacecraft contractor shall provide sufficient component level analysis data to permit computer simulation of the communications subsystem performance in accordance with CDRL SDA-3.2.8-02.

3.2.9 Telemetry and Command

The spacecraft contractor shall provide all personnel, facilities, services, and materials necessary to develop, verify, and maintain a design for the GOES N-Q telemetry and command subsystem. The spacecraft contractor shall provide the following:

1. Telemetry and command subsystem performance analysis report as described in CDRL SDA-3.2.9-01.
2. Telemetry and command handbook in accordance with CDRL SDA-3.2.9-02.
3. Command Encrypter maintenance and operations manual, security plans and an interface description document as defined in CDRL SDA-3.2.9-03

3.2.10 Mechanisms

The spacecraft contractor shall provide all personnel, facilities, services, and materials necessary to develop, verify, and maintain a design for the GOES N-Q mechanisms subsystem. This includes all deployable mechanisms, electro-mechanical devices, and associated control electronics. The spacecraft contractor shall provide block diagrams, mathematical models, and worst case analyses to support the

designs. The spacecraft contractor shall provide a mechanisms subsystem performance analysis report as described in CDRL SDA-3.2.10-01.

3.2.11 Instrument Interfaces

The spacecraft contractor shall provide all personnel, facilities, services, and materials necessary to develop, verify, and maintain a design for all the GOES N-Q GFE instrument (Imager, Sounder, and SXI) interfaces. The design shall include the mechanical, thermal, structural, electrical, telemetry and command, contamination, and INR interfaces between spacecraft and instruments, spacecraft and SSGS, instruments and SSGS, and spacecraft GSE and instrument GSE.

3.2.11.1 Spacecraft Contractor-Provided Instrument Interface Hardware

The spacecraft contractor shall provide all personnel, facilities, services, and materials necessary to develop, verify, and maintain intra-instrument harness and mechanical mount designs as required for the GFE instruments.

3.2.11.2 Interface Design Support

The spacecraft contractor shall document spacecraft-relevant aspects of the spacecraft to GFE instrument interfaces in the GFE instrument ICDs. The interface design shall be coordinated with the GFE instrument contractors. The spacecraft contractor shall provide engineering support to the GFE instrument contractors for the design, verification, and maintenance of the GFE instrument thermal blankets. The spacecraft contractor shall provide engineering support to the GFE instrument contractors for the design, verification, and maintenance of the new or modified GFE instrument hardware or firmware (if any) required to accommodate the spacecraft interface.

The spacecraft contractor shall analytically estimate the total radiation dosage that each of the GFE instruments' electronic and optical components will receive over the operational life of the spacecraft. Drawings of the GFE instrument modules shall be provided by NASA for use in calculating radiation dosage. This analysis shall be documented per the requirements of CDRL SE-2.5-06.

3.2.11.3 Advanced Imager, Advanced Sounder and Lightning Mapper (LM) Accommodation

The spacecraft contractor shall develop and maintain a spacecraft design that simultaneously accommodates the LM instrument, the Advanced Imager, and the Advanced Sounder. Advanced Imager or Sounder accommodation shall be provided in place of the Imager or Sounder, respectively. LM accommodation shall be in addition to the SEM, SXI, Imager/Advanced Imager, and Sounder/Advanced Sounder instruments.

3.2.11.4 SXI to Spacecraft Harness

The spacecraft contractor shall design and develop the harnesses interconnecting the electronic boxes, the telescope to the electronic boxes, and the SXI system to the spacecraft for the instrument level EMI/EMC tests.

3.2.12 Flight and Electrical GSE Software Design and Analysis

The contractor shall provide all personnel, facilities, services, and materials necessary to develop, verify, assure the quality of, and maintain all aspects of the flight and electrical GSE software development for the GOES N-Q spacecraft. All flight software shall be developed in accordance with sections 10.9 and 10.10 of the GOES N-Q Performance Specification, S-415-22. The spacecraft contractor shall treat the software component of firmware, which consists of computer programs and data loaded into a class of memory which cannot be dynamically modified by the computer during processing (e.g., programmable read-only memories, programmable logic arrays, digital signal processors, etc.), as software for the purposes of this SOW.

3.2.12.1 Software Management and Development

The spacecraft contractor shall provide the management functions necessary for the development of all flight and electrical ground support equipment software for the GOES N-Q spacecraft.

3.2.12.2 Software Requirements Specification Generation

The spacecraft contractor shall perform all analyses and systems engineering required to allocate (from system and subsystem requirements) and identify software requirements, and to develop the design specifications for GOES flight and electrical GSE software CSCIs. For each CSCI, software requirements shall be specified in a software requirements specification (SRS) (CDRL SDA-3.2.12-01) provided for government review. Software requirements traceability to system and subsystem requirements shall be provided in a traceability matrix as part of the SRS. The spacecraft contractor shall provide a software configuration management (SCM) system to control the configuration of the software code and maintain consistency between software code, software documentation, and subsystem documentation. In particular, an SCM process shall be used to control and maintain consistency of the attitude control subsystem and electrical power and distribution subsystem algorithm documents (CDRLs SDA-3.2.12-9 and -10), the software requirements specification (CDRL SDA 3.2.12-01), the software design document (CDRL SDA-3.2.12-02), and the software user and maintenance manual (CDRL SDA-3.2.12-07), as well as the code itself. The Version Description Document (VDD) shall be prepared in accordance with CDRL SDA-3.2.12-06. The Software Management, Development and Assurance Plan shall be prepared and submitted in accordance with CDRL SDA-3.2.12-12.

3.2.12.3 Firmware Requirements and Design

The software component of firmware, which consists of computer programs and data loaded into a class of memory which cannot be dynamically modified by the computer during processing shall be specified, designed, developed, and tested in the same rigorous manner as the flight software. Firmware requirements, design, testing, version control, and installation procedures shall be described in the firmware support manual (CDRL SDA-3.2.12-08).

3.2.12.4 Flight Software Maintenance

The spacecraft contractor shall be responsible for maintenance of the flight software for each spacecraft. Flight software maintenance shall include identification and isolation of flight software problems; specification, design, and testing of appropriate changes, modifications, or patches to the flight software; creating a flight software patch or image in a form suitable for uplink to the spacecraft; and verification that the patch or modification has been successfully uploaded and functions correctly. The use and maintenance of the GOES N-Q flight software shall be described in a software user and maintenance manual (CDRL SDA-3.2.12-07).

3.2.12.5 Software Development and Validation Environment

The contractor shall provide all personnel, facilities, services, and materials necessary for the design of the Software Development and Validation Environment described in the section 10.9.12 of the Performance Specification. Furthermore, the contractor shall identify and include all required components of this system to be installed into the government operations center.

3.2.13 Spacecraft Emulators

The spacecraft contractor shall provide all personnel, facilities, service and materials necessary to develop, verify and maintain a design for the GOES N-Q spacecraft emulator as specified in section 11.3 of the Performance Specification. The spacecraft contractor shall provide the design document and maintenance manuals as described in CDRLs SDA-3.2.13-01 and SDA-3.2.13-02. Spacecraft emulator design reviews are defined in section 1.1 of this document.

Three spacecraft emulators shall be developed satisfying the requirements of Performance Specification S-415-22, section 11.3 and all subparagraphs: One shall be for use at the spacecraft contractor's facility, and two shall be delivered to a government designated facility.

(Deleted two paragraphs)

3.2.14 Space Environment Monitor Instruments

The spacecraft contractor shall provide all personnel, facilities, services, and materials necessary to develop, verify, and maintain a design for all the GOES N-Q SEM instruments (EPS, HEPAD, Magnetometer, XRS/EUV).

The spacecraft contractor shall prepare a SEM data and calibration handbook in accordance with CDRL SDA-3.2.14-01.

The spacecraft contractor shall prepare a spacecraft magnetic control plan for magnetometer performance assurance in accordance with CDRL SDA-3.2.14-02.

3.2.15 SXI Related Tasks

The spacecraft contractor shall analyze the SXI pointing and jitter performance in accordance with CDRL SDA-3.2.14-03.

3.2.16 Image Navigation and Registration

The spacecraft contractor shall provide all personnel, facilities, services, and materials necessary to develop, verify, and maintain the INR design for GOES N-Q.

The spacecraft contractor shall prepare the following:

1. INR System Description and Analysis document as described in CDRL SDA-3.2.16-01.
2. INR Related System Performance Report as defined in CDRL SDA-3.2.16-02.
3. INR Test Plan in accordance with CDRL SE-2.4-01.

3.2.16.1 INR Performance Evaluation System

Recognizing that a comprehensive system test of INR performance prior to launch is not feasible, the spacecraft contractor shall provide all personnel, facilities, services, and materials necessary to design, verify, and maintain the design for two INR performance evaluation systems, one for the spacecraft contractor and one for NASA. The performance evaluation system shall accurately model/simulate all known INR pointing error sources, in accordance with the requirements of the GOES N-Q Performance Specification, S-415-22. The performance evaluation system shall be updated for a period of one year after launch of GOES N to include system modifications, measured INR pointing errors, unaccounted for INR pointing errors, and seasonal effects.

3.2.17 Contamination Control

The spacecraft contractor shall provide all personnel, facilities, services, and materials necessary to develop, verify, and maintain a design for the GOES N-Q contamination control subsystem. The spacecraft contractor shall develop a contamination control plan in accordance with CDRL SDA-3.2.17-01 which meets the requirements of the GOES Performance Specification, S-415-22, section 10.11. The spacecraft contractor shall provide a launch environment consistent with the instrument and spacecraft cleanliness requirements. The spacecraft contractor shall update the "Fallout Plate Installation and Removal Procedure and Fairing Tapelift Sampling Plan," S-415-28, and the "Launch Site Purge Plan for the Geostationary Operational Environmental Spacecraft (Satellite)," S-415-29, as necessary for the proposed design; the update shall include supporting cleanliness data obtained using analytical modeling techniques or equivalent.

3.2.18 On-board Computer (OBC)

The spacecraft contractor shall provide all personnel, facilities, services, and materials necessary to design, verify, and maintain a design for the GOES N-Q OBC subsystem(s). The OBC shall conform to all requirements specified in the GOES N-Q Performance Specification, S-415-22, sections 10.9 and 10.10.

The spacecraft contractor shall prepare a flight computer design description as defined in CDRL SDA-3.2.12-11

3.3 Subsystem Fabrication, Assembly and Test

The spacecraft contractor shall furnish all necessary personnel, facilities, services, and materials to support subsystem fabrication, assembly, and test efforts for GOES N-Q including all required spares. All subsystem and component testing shall be performed with calibrated GSE. The spacecraft contractor shall perform subsystem level verification testing with test methodologies proposed for on-orbit testing to the maximum extent possible.

The spacecraft contractor shall prepare the component/subsystem test procedures and test data packages as defined in CDRL SFAT-3.3.1-01 and SFAT-3.3.1-02, respectively.

3.3.1 Management

The spacecraft contractor shall provide the management functions necessary to support efforts associated with the subsystem fabrication, assembly, and test activities for GOES N-Q.

3.3.2 Structures

The spacecraft contractor shall provide all personnel, facilities, services, and materials necessary to fabricate, assemble, and test the GOES N-Q structures subsystem. This includes the main body, solar array structure, appendage devices, and spacecraft-to-launch vehicle separation system.

3.3.3 Propulsion

The spacecraft contractor shall provide all personnel, facilities, services, and materials necessary to fabricate, assemble, and test the GOES N-Q propulsion subsystem.

3.3.4 Attitude Control

The spacecraft contractor shall provide all personnel, facilities, services, and materials necessary to fabricate, assemble, and test the GOES N-Q attitude control subsystem.

3.3.5 Thermal Control

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The spacecraft contractor shall provide all personnel, facilities, services, and materials necessary to fabricate, assemble, and test the GOES N-Q thermal control subsystem. Subsystem tests (solar beam, heater, IR lamps) shall be performed if validation data is required.

3.3.6 Power and Electrical

The spacecraft contractor shall provide all personnel, facilities, services, and materials necessary to fabricate, assemble, and test the GOES N-Q power and electrical subsystem.

3.3.6.1 Battery Test Cells

The spacecraft contractor shall deliver five activated battery cells from each activation lot, matched per spacecraft flight battery requirements, to NASA for performance testing. An activation lot is defined as a group of cells that receive electrolyte together via the same procedure. An activation lot can be the entire production lot or a subset of the production lot, depending on the quantity needed at the time of activation.

3.3.7 Ground Support Equipment

The spacecraft contractor shall provide all personnel, facilities, services, and materials necessary to fabricate, assemble, and test the GOES N-Q subsystem electrical and mechanical ground support equipment.

3.3.8 Communications

The spacecraft contractor shall provide all personnel, facilities, services, and materials necessary to fabricate, assemble, and test the GOES N-Q communications subsystem.

3.3.8.1 Communication Models

The spacecraft contractor shall provide NASA sufficient engineering model or first flight article measurement data in order for NASA to verify the PDR analysis predictions and for NASA to create a computer simulation model of each signal path within the spacecraft (CDRL SDA-3.2.8-02). This model data shall permit evaluation of all the transmission channel characteristics for each spacecraft signal path.

The spacecraft contractor shall provide to NASA sufficient flight hardware measurement data in order for NASA to create a computer simulation model of each signal path within each spacecraft of the series. This model data shall permit evaluation of all the transmission channel characteristics for each spacecraft signal path.

3.3.8.2 Testing Measurements

The spacecraft contractor shall trace the signal paths used for each measurement and analytically determine that each measurement has the proper bandwidth, power levels, and signal-to-noise ratios at each sensor's most accurate range of measurement. The spacecraft contractor shall include analyses of the various sources of error for each measurement and calculate the accuracy (2-ó variation) of each communications subsystem verification test. (CDRL SDA-3.2.8-01)

3.3.8.3 BER Testing

The spacecraft contractor shall provide test configurations with sufficiently controlled hardware distortions to verify conformance with the communication function BER requirements specified in S-415-22. The BER test shall have loop back modes to characterize the test equipment back-to-back BER implementation losses. These back-to-back implementation loss factors shall be shown in each test result. All BER E_b/N_0 calculations shall be based on measurements of true power, with the usage of peak detectors forbidden. In these tests, adjacent channel modulated signals shall be present at their dynamic range maxima. The PDR, WEFAX, and EMWIN test configurations shall include the same or equivalent uplink filters used at the CDAS to confine the signal spectra to the assigned channel frequency bands.

For the DCPR and DCPI channels it only shall be necessary to characterize the BER curve of the 100 bps BPSK signal structures and to characterize those curves down to a probability of error level of 10E-4. For the EMWIN channel the BER curve shall be characterized down to a probability of error level of 10E-5, excluding the coding gain. CCR6017C Mod 32

For the Imager, at least six points on the probability of error curve shall be determined. Due to the low data rate of the 40 kbps Sounder and the resulting high signal-to-noise margin, the 40 kbps Sounder channel shall be tested for 30 minutes to demonstrate the 10E-8 probability of error (i.e., no errors) when the Imager BER is set to approximately 10E-5.

The BER testing may be performed excluding coding. For the SAR channel the BER testing may be performed with a continuous PN stream.

3.3.8.4 Spurious Emission Tests

Spurious emission testing shall be performed for each channel.

3.3.8.4.1 Spurious Emission Tests For All Channels Except DCPR

The spacecraft contractor shall comply with the spurious emission requirements of S-415-22, section 10.2, testing each separate transmission channel as detailed below. Table 3.3.8.4.1-1 lists the requirements for loading the channel under test, the spurious signal limit referenced to the loading signal power, and the compliance bandwidth centered at the downlink frequency. All uplink signals to the other transmission channels shall be configured according to Table 3.3.8.4.1-2. The SAR repeater channel spurious requirements shall be met when the downlink is measured at the output of a phase modulation receiver.

Table 3.3.8.4.1-1
Spurious Emissions Channel Under Test Signal Specification

Channel Designation	Spurious Channel Under Test Requirements
Sensor Data Transmitter	Unmodulated carrier, -50 dBc, 6.0 MHz
PDR Repeater	Contin. Wave (CW) uplink @ -96 dBm, -50 dBc, 5.0 MHZ
WEFAX Repeater	CW uplink @ -107 dBm, -50 dBc, 1.0 MHz
EMWIN Repeater	CW uplink @ -114 dBm, -50 dBc, 100 kHz
DCPI Repeater	CW uplink @ -114 dBm, -50 dBc, 300 kHz
DCPR Repeater	CW uplink @ -100 dBm, -60 dBc, 425.0 kHz

SAR Repeater - Wideband	CW uplink @ -125 dBm, -35 dBc, 100 kHz; fixed gain
SAR Repeater - Narrowbnd	No uplink; no spurs $ 10 dB-Hz; 10 kHz; fixed gain
MDL Transmitter	Unmodulated carrier, -50 dBc, 1.0 MHZ
Command Receiver	Verify compliance to coherent functions requirements
DSN Telemetry Transmitter Noncoherent Coherent	 Unmodulated carrier, AUX OSC mode, -50 dBc, 2.5 MHZ Unmodulated carrier, ranging ON, -50 dBc, 1.5 MHZ
CDA Telemetry Transmitter	Unmodulated carrier, -50 dBc, 30 kHz

Table 3.3.8.4.1-2
Spurious Emissions - Other Channel Configuration Requirements

Channel Designation	Spurious Requirement - Other Channel Configuration
Sensor Data	Modulated with Pseudo Noise (PN) sequence, NRZ-S, OQPSK
PDR	Modulated with PN sequence, NRZ-S, 2.11 Mbps BPSK
WEFAX	Modulated with PN sequence, NRZ-M, 293 ksps BPSK
EMWIN	Modulated with PN sequence, NRZ-M, 25 ksps BPSK
DCPI	DCPI modulated signal
DCPR	See Section 3.3.8.4.2, below
SAR	No uplink
MDL	Modulated with PN sequence, 400 kbps, QPSK
Command Receiver	Coherent mode
DSN Telemetry	Modulated with data, coherent mode, ranging ON
CDA Telemetry	Modulated with data

3.3.8.4.2 DCPR Spurious Emission Test

The spacecraft contractor shall demonstrate that spurious emissions meet the specified requirements of S-415-22, section 10.2 for the DCPR channel, by performing a noise power ratio test for each channel on each spacecraft at any verification test level. After demonstrating compliance with the noise power ratio test, the contractor may elect to use a two-signal linearity test at any level of integration.

A two signal test shall use two equal input power sinusoids (carriers), such that the total power is equal to the dynamic range maximum and the two sinusoids are separated in frequency by 2 kHz. Any resulting intermodulation products shall not be greater than 25 dB below the power in one tone.

3.3.8.5 Interference Testing

The spacecraft contractor shall perform worst-case interference testing for the 1670 to 1695 MHZ downlinks. Each transmission channel under test shall be tested at the dynamic range maximum, with any other adjacent channel modulated signals present at their dynamic range maximum.

3.3.8.6 Antenna Pattern Measurements

Coverage and polarization measurements shall be performed at an appropriate antenna test facility sufficient to accurately determine the radiation pattern and phase, where appropriate, of each spacecraft antenna. The tests shall be conducted for each spacecraft configuration (with appropriate mockups) in which the antennas will be operated on-orbit . The tabulated antenna data shall be delivered to NASA in a standard electronic format. Refer to CDRL SDA-3.2.8-02.

3.3.8.7 Communication Subsystem to Ground Station Compatibility

The spacecraft contractor shall verify the GOES N-Q communications RF interfaces and data compatibility with ground support facilities. This requirement may be satisfied for the GOES N-Q development by performing hardware testing and providing the resulting data to NASA.

3.3.9 Telemetry and Command

The spacecraft contractor shall provide all personnel, facilities, services, and materials necessary to fabricate, assemble, and test the GOES N-Q telemetry and command subsystem.

3.3.9.1 Telemetry and Command (T&C) RF Link Compatibility Testing

The spacecraft contractor shall verify the GOES N-Q T&C RF interfaces and data compatibility with ground support facilities.

3.3.9.2 T&C Coverage Verification

The T&C coverage verification shall be as per section 3.3.8.4. Refer to CDRL SDA-3.2.9-01.

3.3.9.3 Telemetry System Testing

The communication subsystem design shall permit performance evaluation of telemetered data during integration and test. The telemetry shall be calibrated and measured during environmental testing at the spacecraft level to provide performance reference signatures over temperature. Each verification test shall simultaneously measure any applicable telemetry output, in engineering units, and include this in the data set for review.

3.3.10 Mechanisms

The spacecraft contractor shall provide all personnel, facilities, services, and materials necessary to fabricate, assemble, and test the GOES N-Q mechanisms subsystem. This includes all deployable mechanisms, electro-mechanical devices, and associated control electronics. The spacecraft contractor shall perform force and/or torque margin tests in addition to functional tests, as specified in S-415-22, section 10.8.1. Life testing shall be performed for all devices with moving friction generating components, lubricants, or flexing members as specified in S-415-22, section 8.6.9.

The spacecraft contractor shall calibrate the commanded vs. actual motion of all mechanisms that are regularly used during on-orbit operations, such as the solar array.

3.3.11 Instrument Interfaces

The spacecraft contractor shall provide all personnel, facilities, services, and materials necessary to fabricate, assemble, and test the GFE instrument (Imager, Sounder, SXI) interfaces. The interfaces between spacecraft and instruments, spacecraft and SSGS, instrument and SSGS, and spacecraft GSE and instrument GSE shall include the mechanical, thermal, structural, electrical, telemetry and command, contamination, and INR.

3.3.11.1 Spacecraft Contractor Provided Instrument Interface Hardware

The spacecraft contractor shall provide all personnel, facilities, services, and materials necessary to fabricate, assemble, and test the intra-instrument harness and mechanical mount designs as required for the GFE instruments. NASA will provide matched tooling plates of the GFE Imager and Sounder sensor/telescope module and electronics/power supply modules for the spacecraft contractor's use in developing the Imager and Sounder mechanical interfaces.

NASA will provide an SXI mass simulator for the spacecraft contractor's use in developing the SXI mechanical interface.

3.3.11.2 Interface Design Support

The spacecraft contractor shall provide engineering support to the GFE instrument contractors for the fabrication, assembly, and test of the GFE instrument thermal blankets. The spacecraft contractor shall provide engineering support to the GFE instrument contractors for the fabrication, assembly, and test of new or modified instrument hardware or firmware (if any) required to accommodate the spacecraft interface.

3.3.11.3 Advanced Imager, Advanced Sounder and Lightning Mapper (LM) Accommodation

The spacecraft contractor shall provide the interface defined in S-415-22 and the instrument ICDs (as applicable) for the Advanced Imager, Advanced Sounder, and LM. Accommodations outside of those specified shall be jointly developed by the spacecraft contractor and appropriate instrument contractor.

3.3.11.4 SXI to Spacecraft Harness

The spacecraft contractor shall fabricate and deliver the harnesses interconnecting the electronic boxes, the telescope to the electronic boxes, and the SXI system to the spacecraft for the instrument level EMI/EMC tests.

3.3.12 Flight and Electrical GSE Software Coding and Testing

The spacecraft contractor shall design and test the GOES N-Q flight software and associated electrical GSE software to ensure that it meets all its requirements as described in the SRS and functions as intended. A specific and widely-accepted, industry standard design methodology (e.g., structured analysis and design, object modeling technique, Booch Method, etc.) shall be employed in the design of the GOES N-Q flight software and associated electrical GSE software.

Software test and delivery reviews are defined in section 1.1, Program Reviews.

3.3.12.1 Flight Software Design and Development

The spacecraft contractor shall provide a software design which meets all the requirements specified in the SRS and functions as intended. The software design shall be described initially in a software design document (CDRL SDA-3.2.12-02), which shall be fully traceable to the SRS as described in a software design traceability matrix included in the software design document.

3.3.12.2 Requirements, Design and Code Walkthroughs

Requirements, design, and code walkthroughs or inspections, open to government participation, shall be conducted at the spacecraft contractor's facility at the appropriate software developmental life-cycle phase to ensure the correctness of the requirements, design, and source code. NASA-STD-2202-93, Software Formal Inspections Standard, and NASA-GB-A302, Software Formal Inspections Guidebook, may be used a guidelines for conducting the code walkthroughs or inspections. The coding, debugging, and developer testing efforts, the results of the walkthroughs, and programmer's notes shall be documented in software development folders, available at the spacecraft contractor's facility for government review.

3.3.12.3 Software Verification and Validation Testing

The spacecraft contractor shall provide all the resources necessary to verify and validate all the software developed for the GOES N-Q spacecraft. Software verification and validation activities shall be described in a software test plan (CDRL SDA-3.2.12-03). A software test procedures document (CDRL SDA-3.2.12-04) shall describe the step-by-step, detailed procedures for testing the GOES N-Q software. The software test plan and software test procedures shall be fully traceable to the SRS as described in a software test requirements traceability matrix to be included in the software test plan. The spacecraft contractor shall utilize an independent verification and validation (IV&V) test team to assure implementation compliance with applicable requirements during all software testing. A software test report (CDRL SDA-3.2.12-05) shall describe the results of the software testing.

3.3.12.4 Software Development and Test Software

The spacecraft contractor shall provide all the resources necessary to develop, verify, and maintain the development and test software for the GOES N-Q spacecraft. The spacecraft contractor is encouraged to use existing and commercial-off-the-shelf development and test tools. The configuration of development and test software shall be controlled by the spacecraft contractor.

3.3.12.5 Software Development and Validation Environment

The spacecraft contractor shall provide all personnel, facilities, services, and materials necessary for the development and installation of the Software Development and Validation Environment described in section 10.9.12 of the Performance Specification.

3.3.13 Spacecraft Emulators

The spacecraft contractor shall provide all personnel, facilities, services, and materials necessary to fabricate, assemble, and test the GOES N-Q spacecraft emulators. The government will provide the spacecraft contractor with the GFE instrument simulators. The spacecraft contractor shall integrate these GFE instrument simulators into the spacecraft emulator systems for delivery. The spacecraft emulators and associated manuals shall be delivered to NASA, NOAA or instrument contractors, as required, for use in executing simulations, training, and validating command procedures and databases.

Two spacecraft emulators shall be fabricated, assembled, and tested that satisfy the requirements of S-415-22, section 11.3 and all subsections: one shall be for use at the spacecraft contractor's facility, and one shall be delivered to a government designated facility.

As a minimum, elements of the emulator that meet the requirements of S-415-22, subsections 11.3.1.1, 11.3.1.2, 11.3.1.3 and 11.3.1.5 shall be provided to the Imager/Sounder contractor. One unit shall be fabricated, assembled, and tested.

As a minimum, elements of the emulator that meet the requirements of Performance Specification S-415-22, subsections 11.3.1.1, 11.3.1.2, 11.3.1.4 and 11.3.1.5 shall be provided to the SXI contractor. One unit shall be fabricated, assembled, and tested.

3.3.14 Space Environment Monitor Instruments

The spacecraft contractor shall provide all personnel, facilities, services, and materials necessary to fabricate, assemble, and test the GOES N-Q Space Environment Monitor instruments (EPS, HEPAD, Magnetometer, XRS/EUV).

The Government will provide use of the Goddard Magnetics Test Facility, on a one-time only basis, for leading edge checkout of Space Environment Monitor instruments.

The Government will provide use of the Goddard Materials Engineering Branch Laboratory, on a one-time only basis during the summer 1999 time period, for Magnetometer printed circuit board coupon testing. CCR4156A, Mod 29

3.3.15 On-Board Computer (OBC)

The spacecraft contractor shall provide all personnel, facilities, services, and materials necessary to fabricate, assemble, and test the GOES N-Q on-board computer(s).

3.3.16 INR Performance Evaluation System

The spacecraft contractor shall provide all personnel, facilities, services, and materials necessary to fabricate, assemble, and test the design for two INR performance evaluation systems, one for the spacecraft contractor and one for NASA.

3.4 Integration and Test

The spacecraft contractor shall furnish all necessary personnel, facilities, services, and materials to support all integration and test efforts for GOES N-Q. The spacecraft contractor shall also provide the necessary technical efforts to assure that problems are adequately addressed as they arise. Spacecraft testing shall be performed with calibrated GSE. The spacecraft contractor shall prepare the spacecraft test data packages as defined in CDRL I&T-3.4.4-02.

The spacecraft contractor shall establish a system for trending test data of spacecraft components during spacecraft level testing. A matrix of the components being trended shall be presented at the PER and the trend data shall be presented during the PSR for each spacecraft. Additionally, during the PER, the spacecraft contractor shall define for each parameter trended how the data is analyzed and interpreted with respect to the allowable test limits of the data as the testing progresses through the test phases. Any anomalous changes and/or trend(s) in the data shall be explained during the PSR. The spacecraft trend data shall be made available to government and authorized contractor personnel via the EDDS defined in section 1.3.1.

The spacecraft contractor shall prepare the launch commit criteria in accordance with CDRL I&T-3.4.6-02.

3.4.1 Management

The spacecraft contractor shall provide the management functions necessary to support efforts associated with the integration and test activities for GOES N-Q. The spacecraft contractor shall develop all plans,

procedures, and reports necessary to insure and document a successful spacecraft integration and test activity.

3.4.2 Bus Integration

The spacecraft contractor shall provide all resources to perform all electrical, mechanical, and thermal integration and test efforts required for GOES N-Q.

3.4.3 Instrument and Test Equipment Integration

3.4.3.1 Instrument Delivery

The spacecraft contractor shall provide the necessary clean room area, office space, and support to each instrument to aid in the effort associated with the post-ship/pre-integration functional testing of the GFE instruments.

3.4.3.2 GFE Test Equipment Accommodation

The spacecraft contractor shall accommodate the GFE instrument test equipment: floor space, clean room area, facility power, and other routine resources shall be provided for the instrument EGSE, collimators, integrating spheres, and support equipment. The spacecraft contractor shall integrate the GFE instrument GSE with the spacecraft GSE in accordance with the GSE interface ICD. The spacecraft thermal/vacuum chamber shall accommodate infrared targets, space target(s), radiative heating elements as required, and the associated target controllers, plumbing, and wiring. The spacecraft contractor shall design and build the mechanical fixtures necessary to mount and align the GFE targets and equipment in the thermal vacuum chamber. The spacecraft contractor shall integrate the instrument test equipment into the thermal/vacuum chamber with the assistance of the instrument contractors. The spacecraft contractor shall provide the coolants to operate the GFE targets. The spacecraft contractor shall provide facilities to store the GFE test equipment delivered to its facility when the equipment is not in use. GFE test equipment accommodations shall be developed jointly between the spacecraft and instrument contractors, and documented in the GFE Instrument Interface Document for each GFE instrument.

3.4.3.3 GFE Test Equipment Validation (GOES-N Only)

For the GOES-N spacecraft only, the spacecraft contractor shall support the validation of GFE thermal/vacuum test equipment by assisting with the installation of the GFE thermal/vacuum equipment in the chamber, along with any spacecraft fixtures or equipment needed to support the instrument equipment, and executing a thermal cycle in vacuum in order to verify heater and target operation.

3.4.3.4 Prototype Instrument Integration and Test (GOES-N Only)

For the GOES-N spacecraft only, the spacecraft contractor shall integrate the prototype GFE Imager and Sounder and engineering model SXI instruments onto the spacecraft and provide access to the spacecraft, the spacecraft GSE, and personnel to support instrument testing and GSE interface verification for a

duration of 40 16-hour days. Spacecraft integration and testing may be conducted in parallel if it does not interfere with or compromise instrument testing.

3.4.3.5 Flight Instrument Integration

The spacecraft contractor shall provide all resources necessary to perform the electrical, mechanical, and thermal integration of the Imager, Sounder, Solar X-ray Imager, and Space Environment Monitor instruments onto the spacecraft. The spacecraft contractor shall develop and maintain integration and handling procedures which are agreeable to the instrument contractors.

In the spacecraft contractor's SXI integration sequence, the contractor shall allot one day for the SXI contractor to execute an SXI functional test after each major integration step; for example, after SXI integration to the mounting panel; after mounting panel integration to the solar array yoke; and after yoke integration to the spacecraft body. If any of these major integration steps are subsequently reversed (e.g., if the yoke is removed from the spacecraft), the spacecraft contractor shall allot one day for the SXI functional test after the de-integration step and then one other day after the re-integration step. These test times are in addition to those defined in Table 3.4.5.1. Spacecraft integration and testing may be conducted in parallel if it does not interfere with or compromise SXI testing. The SXI functional test will be executed by the SXI contractor with support from the spacecraft contractor.

3.4.4 Functional Tests

The spacecraft contractor shall provide all test facilities and all the resources necessary to define, prepare, perform, document, and analyze all functional and performance tests associated with GOES N-Q. The spacecraft contractor shall conduct functional testing as defined in S-415-22 section 8.0. In addition, launch vehicle adapter compatibility shall be verified by test on all spacecraft prior to shipment to the launch base. System testing is defined in section 3.6.2.3

All electrical interfaces shall be verified prior to any first time connection. Safe-to-mate procedures shall be implemented for all interfaces between any two of the following: spacecraft, GFE, EGSE, pyrotechnics, electrical explosive devices, SSGS, ATE, and any facility power. The EGSE shall be demonstrated to NASA to verify that it is adequate for the intended use. EGSE shall be under configuration control prior to the demonstration, and prior to use for spacecraft tests. The spacecraft contractor shall ensure that the instrument GSE is on, operational, and properly connected to the spacecraft GSE prior to any powered testing of an instrument.

<u>The SXI GFE instrument shall be allotted 20 hours for safe-to-mate/electrical signal characterization activities as defined in the SXI/Spacecraft GSE ICD. Twenty (20) hours shall be allotted for the SXI Engineering Model and each and every SXI Flight Model.</u> CCR4174

3.4.4.1 GOES-N Functional Tests With GFE Prototype Imager, Sounder and Engineering Model SXI

For the GOES-N spacecraft only, the spacecraft contractor shall perform the following tests after integration of the prototype Imager and Sounder instruments and an engineering model of the SXI:

1. A test with the spacecraft suspended with all mechanisms operating in an on-orbit mode to measure dynamic interactions between spacecraft and instrument components. The spacecraft contractor may substitute a similarly comprehensive test using the prototype Imager and Sounder instruments

and engineering model SXI to verify dynamic interactions between the instruments and spacecraft mechanisms.
2. A test with all communications functions and instruments operating in an on-orbit mode to measure electromagnetic interactions between the spacecraft and instruments.

The times for these tests are not included in the instrument schedule duration.

3.4.4.2 GOES N-Q Functional Tests with Flight Instruments

The spacecraft contractor shall set aside the schedule durations defined in Table 3.4.5.1 for instrument functional testing at the test phases indicated. The spacecraft contractor shall provide access to the spacecraft, spacecraft GSE, and personnel as required to support the testing. The spacecraft contractor shall support instrument Pre-Vibration Functional Testing by orienting the spacecraft such that the Imager and Sounder cooler cover door hinge axes and telescope optical axes are perpendicular to the ground. If the SXI is integrated on the solar array yoke when a first-motion and/or deployment test of the solar array is performed (during the Baseline Performance and/or the Launch Base Functional phase), the spacecraft contractor shall divide the test time allotted for the SXI in Table 3.4.5.1 such that there are at least two days of SXI test time both before and after the array test. Spacecraft testing may be conducted in parallel if it does not interfere with or compromise instrument testing.

In addition, the spacecraft contractor shall perform the following tests with the flight instruments for each of the GOES N-Q spacecraft.

1. A test with the spacecraft suspended with all mechanisms operating in an on-orbit mode to measure dynamic interactions between spacecraft and instrument components. The spacecraft contractor may substitute a similarly comprehensive test using the Imager, Sounder, and SXI instruments to verify dynamic interactions between the instruments and spacecraft mechanisms.
2. A test to measure the spacecraft magnetic dipole.
3. A test with all communications functions and instruments operating in an on-orbit mode to measure electromagnetic interactions between the spacecraft and instruments.
4. Calibration of all flight sensors (actual vs measured) and mechanisms (actual vs commanded).

The time for these tests are not included in the instrument schedule duration.

3.4.4.3 INR Pre-launch Spacecraft Test Requirements

The spacecraft contractor shall perform the tests necessary to verify the successful system integration of the Imager/Sounder and spacecraft subsystems comprising and/or supporting the INR subsystem (CDRL SE-2.4-01). These tests shall verify that GOES N-Q meets the INR derived requirements and objectives, based on the INR specifications.

The contractor shall propose the tests to be performed; provide the test plan and test procedure in accordance with CDRL SE-2.4-01; provide the necessary input data, files, etc. required to perform the test; and conduct the actual testing.

The spacecraft contractor shall evaluate and document all analyses of the data and information from all tests, including development/bench testing, qualification testing, acceptance testing, and compatibility testing of the INR-related flight hardware, software and algorithms. The spacecraft contractor shall provide a standard format to be used to report the results of all tests.

The spacecraft contractor shall provide and maintain an INR test schedule showing initial availability of each unique GSE and any associated software required for the conduct and/or analysis of the test results. The test schedule shall reflect the requirement for any government furnished data, such as star/landmark data from on-orbit spacecraft (GOES I/M series).

3.4.4.3.1 Spacecraft Subsystem Tests

The purpose of subsystem testing is to verify the functional and computational performance of all spacecraft INR subsystem components. This shall be accomplished by closed loop testing of all INR components provided by the contractor and shall exercise all electrical interfaces using test scenarios which duplicate the worst case on-orbit operational modes and geometries. The output of all subsystem components will be verified both qualitatively and quantitatively. In particular, the comprehensive verification of all INR compensation signals shall be demonstrated during these tests. One important aspect of this testing shall be the confirmation that compensation signals are compatible with the instrument servos. Exercising of the ACS may be accomplished using simulated sensor/actuator signals and/or dynamic simulation with a controllable platform. External interfaces with the INR subsystem during these tests, such as with instruments and ground system elements, shall be provided by flight-like hardware and/or dynamic simulation. In support of these tests, the spacecraft contractor shall provide the data ingest, archive and processing capability to quickly and accurately verify all INR related signals and on-board computations.

The spacecraft contractor also shall prepare INR related system performance reports in accordance with CDRL SDA-3.2.16-02.

3.4.4.3.2 System Tests

The primary objective of system testing is the verification of INR operation and performance at the spacecraft level with all spacecraft components and instruments integrated. Tests shall exercise all worst case expected on-orbit INR operational modes and geometries. As a final verification of system pointing performance, these tests shall include both electrical testing of all INR functions as well as an optical test using the GFE wide field of view collimator (WFC) and wide field of view targets to be provided by the government and, if desired, target(s) developed by the spacecraft contractor. The test data shall be recorded for later testing with the NOAA SSGS.

As a minimum, the WFC shall be used to determine the Imager scan linearity and the amount of shear. These tests shall be performed with IMC both on and off using different orbits and attitudes. Specifically, the spacecraft contractor shall verify image quality over the entire Imager field of regard while operating the INR subsystem. These tests shall be performed for both qualification and acceptance testing on GOES-N, and as acceptance tests on GOES-O,P,Q. For INR tests involving the Imager and

Sounder, the spacecraft contractor shall coordinate the development and execution of the tests with the Imager/Sounder contractor.

The final part of the INR system testing shall be the verification of spacecraft subsystem operation with a replicated and/or emulated ground system. Tests shall be performed with IMC both on and off, and with different orbits and attitudes to fully exercise all of the INR supporting hardware, software, and algorithms.

3.4.4.4 Communications Tests

The spacecraft contractor shall propose the communications tests to be performed to show compliance for each channel and for the system, from assembly through system integration and test. Tests that are proposed to be performed a limited number of times, if successful, shall be clearly indicated along with the criteria for success.

3.4.4.4.1 Simulated On-orbit Communications Test Configuration

This test configuration shall simulate on-orbit operation, where all mission signals are being simultaneously transmitted to the spacecraft. It shall be used as a part of the final communications subsystem integration testing on the spacecraft, and in the RF airlink spacecraft level test.

The attached table provides the channel signals that shall be used for the tests. The sensor data, MDL, and telemetry signals shall be a part of the downlink only. The modulation shall be removed from the signal in the channel under test, leaving only the unmodulated carrier in that channel. Also, the unmodulated carrier may be set to a level 3 dB below the dynamic range maximum, in order to avoid overloading a receiver with multiple inputs. The channel downlink shall be observed for spurious, cross-talk, and intermodulation products with a spectrum analyzer swept over a frequency range 1.25 times the channel bandwidth.

Table 3.4.4.4.1
Channel Signals for On-Orbit Communications Tests

Channel	Signals to be Used in the Channels Not Under Test
Sensor Data	Modulated with Pseudo Noise (PN) sequence, 2.6 Mbps NRZ-S,
PDR	Modulated with PN sequence, NRZ-S, 2.11 Mbps BPSK
WEFAX	Modulated with PN sequence, NRZ-M, 293 ksps BPSK
EMWIN	Modulated with PN sequence, NRZ-M, 25 ksps BPSK
DCPI	DCPI carrier
DCPR	Loaded with linearity test signal configuration
SAR	No uplink
MDL	PN sequence consistent with Contractor specified signal
Command	Consistent with Contractor specified command link
DSN	Coherent mode; ranging On, no ranging tones; TLM subcarrier with data
CDA Telemetry	Modulated with data

3.4.4.4.2 Diagnostic and Calibration Communications Tests

The following tests shall be performed to provide diagnostic information to NASA and for correlation with on-orbit data.

3.4.4.4.2.1 DCPR Gain-Transfer Characterization

The output signal power versus input signal power over the specified input dynamic range and at the center of the frequency band (i.e., the gain-transfer curve) shall be determined for the DCPR transponder.

3.4.4.4.2.2 SAR Gain-Transfer Characterization

The SAR gain-transfer curves shall be determined when the automatic gain control (AGC) is both on and off (i.e., fixed gain mode). These characterization tests shall be performed over the specified dynamic range and at the center of the frequency band. For this test, the output signal power shall be measured after demodulation by a calibrated phase demodulator.

3.4.4.4.2.3 SAR Modulation Index Versus Input Signal Power

The SAR carrier drop versus the input signal power to the SAR transponder shall be determined over the specified input dynamic range. This test shall determine the input signal power level at which the maximum carrier suppression occurs, and the depth of the carrier suppression.

3.4.4.4.2.4 Transponder Characterization With Input Noise

Each transponder shall be characterized using a spectrum analyzer swept over a frequency range 1.25 times the channel bandwidth with the input to the transponder terminated in its characteristic impedance.

3.4.4.4.2.5 Apparent Noise Figures For the PDR, WEFAX, DCPI and EMWIN

The apparent PDR, WEFAX, DCPI and EMWIN channel noise figures shall be determined from the ratio of the output signal-to-noise to the input signal-to-noise. The input test signals shall be from a test source with a 290 Kelvin noise source. This test shall be done at a minimum of five input signal levels spanning the input dynamic range and at three ambient temperatures: acceptance high and low, and within the mission allowable range.

3.4.4.4.3 RF Airlink Test

An RF airlink test shall be performed to measure EMC/EMI and other effects. This test shall be done with all spacecraft antennas installed and radiating, and in an area confirmed to have a suitable electromagnetic environment for conducting the test. As a part of the test configuration, a separate receiver and supporting test equipment shall be provided to monitor the instantaneous background interference in all test bands. Antennas shall be used to inject signals into the DSN, UHF and S-band channels. The interference measurements for each band shall be determined via cabling from the transmit test ports of the antenna couplers.

Testing shall be performed to determine the presence of interference caused by any GOES components and subsystems, and shall include tests of the ACS, and instruments. The instrument signals also shall be examined for coherent noise in the output data.

3.4.5 Environmental Tests

The spacecraft contractor shall provide all test facilities and all the resources necessary to define, prepare, perform, document, and analyze all functional and performance tests associated with GOES N-Q. The spacecraft contractor shall conduct environmental testing as defined in S-415-22, section 8.0. The spacecraft contractor shall ensure that the instrument GSE is on, operational, and properly connected to the spacecraft GSE prior to any powered testing of an instrument.

3.4.5.1 GOES N-Q Environmental Tests with GFE Instruments

The spacecraft contractor shall schedule the following work days per GFE instrument (i.e., multiply by 3 for the Imager, Sounder, and SXI) for instrument testing during spacecraft environmental testing. Durations assume a 24-hour work day during thermal vacuum testing, and a 16-hour work day for other phases. Durations may be adjusted to accommodate the spacecraft nominal work day as long as the total number of test hours remains constant. The spacecraft contractor shall provide access to the spacecraft, spacecraft GSE, and personnel as required to support the testing. Spacecraft testing may be conducted in parallel if it does not interfere with or compromise instrument testing. The spacecraft contractor shall allow GFE instrument tests to be conducted in parallel with spacecraft testing if they do not interfere with or compromise spacecraft testing. The spacecraft contractor shall keep the GFE instruments on and operating during temperature transitions at all times possible.

3.4.5.2 Visual Monitoring of Imager and Sounder Louvers during Thermal Vacuum Testing

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The spacecraft contractor shall provide the capability to visually monitor the Imager and Sounder louvers during spacecraft level thermal vacuum testing, using two CCTV cameras, two monitors and two VCR's (all provided by the spacecraft contractor). The spacecraft contractor shall provide a fixed mount and mount the two CCTV cameras inside the TV chamber, with an acceptable view of the Imager and Sounder Louvers. A location shall be provided external to the chamber, for viewing the television monitors. Electrical power along with cables, TV chamber feedthroughs, and thermal control (heaters/MLI) to maintain the CCTV cameras within an acceptable operating temperature range, shall be provided and installed.

Table 3.4.5.1
GFE Instrument Test Program Requirements

Test Phase	Days Per Instrument	Additional Requirements
Baseline Performance	10 (30 total)	As defined in section 3.4.4.2
Pre-Vibration Functional	0.5 (1.5 total)	
Post-Vibration Ambient	1 (3 total)	Imager/Sounder cooler door axis vertical
TV Eqpt. Install/checkout/align	3 total	Instrument manufacturing preparations for T/V conducted in parallel
Pre-TV (ambient in chamber)	2 (6 total)	Perform dynamic interaction test
High Temp. Outgassing	8 total*	Note: 7 days outgassing + 1 day for cooler cool down
TV "Hot" Plateau	4 (12 total)	Perform dynamic interaction test. Limit activities which disturb instrument temperature stability.
Mission Ops ETE Test #3	1.33 (32 hrs)	As defined in section 3.6.2.3.2.3
TV "Cold" Plateau	4 (12 total)	Limit activities which disturb instrument temperature stability. Perform dynamic interaction test
Post-TV (ambient in chamber)	2 (6 total)	
Post-TV/Pre-Ship Functional	8 (24 total)	Imager/Sounder cooler door axis vertical, Perform wide field collimator test
Preparation for shipment	2 total	
Launch Base Functional	5 (15 total)	As defined in section 3.4.6.1

* 7 day outgassing is the nominal duration. Outgassing shall continue until TQCM and RGA measurements satisfy the contamination requirements of S-415-22, section 10.11.

The spacecraft contractor shall perform a test with the spacecraft suspended with all mechanisms operating in an on-orbit mode to measure dynamic interactions between the spacecraft and instrument components at the thermal vacuum test mission high and low plateaus. The spacecraft contractor may substitute a similarly comprehensive test using the Imager, Sounder, and SXI instruments to verify dynamic interactions between the instruments and spacecraft mechanisms.

The spacecraft contractor shall support the Imager, Sounder, and SXI testing following both the vibration and thermal vacuum tests. For the Imager and Sounder the spacecraft shall be oriented with the cooler cover door axes and the telescope optical axes perpendicular to the ground.

The spacecraft contractor shall repeat the wide field of view collimator test following the thermal vacuum test.

3.4.6 Launch Site Tests

The spacecraft contractor shall prepare a launch site integration plan as defined in CDRL I&T-3.4.6-01.

3.4.6.1 GFE Instrument Tests

The spacecraft contractor shall set aside the launch base functional schedule duration as defined in Table 3.4.5.1 for instrument functional testing and launch readiness activities, including the inspection and cleaning of the radiant coolers and optical cavities. The spacecraft contractor shall provide access to the spacecraft, spacecraft GSE, and personnel as required to support the testing and launch readiness activities. The spacecraft contractor shall support instrument testing by orienting the spacecraft such that the Imager and Sounder cooler cover door hinge axes and telescope optical axes are perpendicular to the ground. The spacecraft contractor shall support launch readiness activities by preparing a class 10,000 clean area where the optical cavities and coolers may be uncovered for inspection and cleaning. The spacecraft contractor shall prepare any lifts/scaffolding required to allow instrument personnel to access the optical cavities and coolers for cleaning activities. The spacecraft contractor shall ensure that the instrument GSE is on, operational, and properly connected to the spacecraft GSE prior to any powered testing of an instrument.

Spacecraft testing may be conducted in parallel if it does not interfere with or compromise instrument testing.

3.4.7 Ground Support Equipment

The spacecraft contractor shall provide all the resources required for the design, development, procurements, fabrication, and test of all electrical ground support equipment (EGSE), mechanical ground support equipment (MGSE), and targets necessary to completely test the spacecraft and verify it meets the specified performance. This includes:

1. Special equipment necessary to handle, store, and transport the spacecraft or its components and any equipment used to perform off spacecraft mechanical testing of appendages or other equipment during integration and test.
2. Automated data processing equipment and software necessary to control and monitor the spacecraft, run the test procedures, and analyze, display and plot the test data.
3. MGSE required to handle and test the SXI in conjunction with the spacecraft.

The spacecraft contractor is responsible for the calibration of the GSE it provides and the instrument contractors are responsible for the calibration of the GFE GSE.

3.4.7.1 GSE for GFE Instruments

The spacecraft contractor shall define, design, develop, fabricate, test, and maintain all GSE necessary to integrate the instruments and accommodate their GSE. The spacecraft contractor also shall define, design, develop, fabricate, test, and maintain all instrument-to-GSE test harnesses. The spacecraft contractor shall provide GSE which performs the functions defined in S-415-22, section 11.2.1.

The spacecraft contractor shall develop, document, verify, and maintain a spacecraft GSE interface-to-instrument GSE interface that is agreeable to the respective GFE instrument contractors in accordance with CDRL SE-2.2-01. The spacecraft contractor shall provide engineering support to the instrument contractors for the definition, design, fabrication, assembly, test, and maintenance of the GSE which interfaces with the spacecraft GSE.

3.4.7.2 Spacecraft Contractor Use of GFE Test Equipment

The GFE instrument test equipment delivered to the spacecraft contractor's facility will be capable of commanding the instruments, collecting and archiving instrument science and telemetry data, performing standardized and customized data analyses, and providing data display. The spacecraft contractor may use the capabilities provided by the GFE test equipment for verification of system level performance parameters such as INR and BER. If the spacecraft contractor chooses to use these capabilities in the spacecraft test program, the spacecraft contractor shall specifically document the roles and responsibilities of GFE and, if required, support personnel. Use of GFE in the spacecraft tests shall be coordinated with the instrument contractors and approved by NASA.

3.4.8 Contamination Control

The spacecraft contractor shall provide all personnel, facilities, services, and materials necessary to assure appropriate contamination control (implementation of CDRL SDA-3.2.17-01) is maintained through all phases of integration and test of GOES N-Q. Refer to S-415-22, section 10.11.

3.4.9 Transportation and Handling

The spacecraft contractor is responsible for all spacecraft and GSE transportation and handling. Spacecraft shipping transporters (including trailers, shipping containers, and environmental control

systems) for GOES N-Q shall be provided by the spacecraft contractor. The spacecraft contractor shall prepare a spacecraft transportation and handling plan in accordance with CDRL I&T-3.4.9-01.

The spacecraft contractor shall obtain any necessary shipping permits and hazardous material exemptions, etc. The spacecraft contractor shall be responsible for obtaining airlift certification for shipment to the launch base. In addition, the spacecraft contractor shall be responsible for the loading and unloading of the aircraft and the transportation from the KSC facility to the spacecraft launch processing facility. Spacecraft transportation also shall be compatible with ground transportation. The spacecraft shall be prepared for shipment as specified in S-415-22, section 10.11.6. During all shipments the spacecraft contractor shall perform real-time monitoring of the shipping and handling environment for all controlled conditions (shock, temperature, air cleanliness, air and/or nitrogen purge, and humidity) while the spacecraft is in the shipping container.

The spacecraft contractor's transportation and handling plan shall incorporate the transportation and handling requirements as specified by the GFE instrument ICDs and S-415-22, section 10.11.6. The spacecraft contractor shall be responsible for transporting GFE GSE after initial NASA delivery.

The spacecraft contractor shall reassemble, as required, and check out all GSE after each shipment, verifying that they are all operating within normal specification limits before their use with the spacecraft. However, NASA will reassemble and checkout GFE GSE.

3.4.10 Storage and Maintenance

The spacecraft contractor shall provide the resources required to design, plan, implement, execute, and manage a GOES N-Q ground storage and maintenance program as defined in CDRL I&T-3.4.10-01.

3.4.10.1 GFE Instrument Requirements

The spacecraft contractor's ground storage plan shall incorporate the storage requirements defined for the GFE instruments by the instrument ICDs. Functional testing of the GFE instruments shall be performed every six months during spacecraft storage. The spacecraft contractor shall support instrument testing for a duration of four days per instrument. The spacecraft contractor shall allow access to the GFE instruments for inspection. All spacecraft, with instruments installed, stored for a period of 24 months or longer since the last thermal vacuum test shall require, as a minimum, an abbreviated post-storage thermal vacuum test to verify instrument performance.

The spacecraft contractor shall schedule the following work days per GFE instrument (i.e., multiply by 3 for the Imager, Sounder, and SXI) for instrument post-storage testing. Durations assume a 24- hour work day during thermal vacuum testing, and a 16-hour work day for other phases. Durations may be adjusted to accommodate the spacecraft nominal work day as long as the total number of test hours remains constant.

The spacecraft contractor shall provide access to the spacecraft, spacecraft GSE, and personnel as required to support the instrument testing. Spacecraft testing may be conducted in parallel if it does not interfere with or compromise instrument testing.

Table 3.4.10.1
GFE Instrument Post-Storage Test Requirements

Test Phase	Days Per Instrument	Additional Requirements
Post-Storage inspection/test	4 (12 total)	Imager/Sounder optical axis vertical
TV Eqpt. Install/checkout/align	3 total	Instrument manufacturing preparations for T/V conducted in parallel.
Pre-TV (ambient in chamber)	2 (6 total)	
High Temp. Outgassing	8 total*	Note: 7 days outgassing + 1 day for cool down of cooler
TV "Hot" Plateau	3 (9 total)	Limit activities which disturb instrument temperature stability
TV "Cold" Plateau	3 (9 total)	Limit activities which disturb instrument temperature stability
Post-TV (ambient in chamber)	2 (6 total)	
Post-TV/Pre-Ship Functional	6 (18 total)	Imager/Sounder cooler door axis vertical

* 7-day outgassing is the nominal duration. Outgassing shall continue until TQCM and RGA measurements satisfy the contamination requirements of S-415-22, section 10.11.

3.4.10.2 Post-Storage End-to-End Verification

The spacecraft contractor shall support end-to-end testing to re-verify proper ground system performance following a ground storage period and prior to launch site shipment. This test will confirm any modifications to command procedures and telemetry processes subsequent to the final procedure and database validation (test 4, described in section 3.6.2.3.2.4).

3.5 Spacecraft Support Ground System (SSGS)

3.5.1 SSGS Requirements

1. The spacecraft contractor shall provide the facilities, materials, and services necessary to design, develop, test, install, integrate, train personnel to use, and document the GOES N-Q SSGS elements; where an SSGS element is defined as a subsystem within the overall GOES SSGS, currently consisting of, but not limited to, the GIMTACS, TACTS, OATS, DID, MPS, SPS, PM, ODAPS, and GVAR simulator. The spacecraft contractor is not bound to replicate or retain the GOES I-M SSGS architecture, except for elements stipulated herein and in S-415-22. The spacecraft contractor shall

use the planned GOES/PACS/IPACS operator workstations to run GOES N-Q GTACS software. The spacecraft contractor can share, if feasible, the GOES I-M OATS DEC Alpha workstations, or provide new, GOES N-Q dedicated systems.

2. The spacecraft contractor shall design, implement, test, integrate, and document all new hardware and software. If GOES I-M hardware reuse is selected, the spacecraft contractor shall develop and implement a test plan to demonstrate that the GOES I-M functions are not affected (CDRL GND-3.5.2-01 through GND-3.5.2-04 and GND-3.5.2-06).
3. The spacecraft contractor shall be responsible for all GOES N-Q SSGS elements until acceptance.
4. The spacecraft contractor shall provide technical operations and maintenance training to government personnel for all GOES N-Q SSGS hardware and software.
5. Delivered GOES N-Q hardware and software shall not obviate, nullify, invalidate, or diminish existing GOES I-M ground system functionality and performance.
6. The spacecraft contractor shall be responsible for the maintenance, operation, calibration, etc. of any SSGS element/capability not located at the SOCC, Wallops CDAS, or backup CDAS, and for any SSGS element at the SEC that is not associated with the SXI or SEM.
7. The spacecraft contractor shall deliver an operational SSGS two months prior to the Earliest Storage Date (ESD) of GOES-N that has been fully checked out and verified with respect to GOES-N performance and compatibility with existing GOES I/M equipment and operation.

3.5.2 Government Furnished Equipment

1. The government will provide, as GFE to the spacecraft contractor, existing GOES ground system software and databases.
2. The government will provide, as GFE to the spacecraft contractor on electronic media and hard copy form, existing ground system documentation for use during spacecraft contractor development of modified/upgraded and new/replaced ground system elements.
3. The government will provide as GFE the required WAN circuit bandwidth between the SOCC and the CDASs, to include T1 multiplexer ports and intra-facility LAN cabling.
4. The government will provide access to GOES I-M SSGS elements at the SOCC and CDASs for software installation, test and integration purposes.
5. The government will not provide ground system hardware for use at the spacecraft contractor's facility.

3.5.3 Management

3.5.3.1 Reviews

SSGS reviews are defined in section 1.1, Program Reviews.

The spacecraft contractor shall provide monthly reports via teleconferences. The monthly teleconferences shall indicate progress during the previous month, problems needing government attention, any government support required for review/test activities, and upcoming milestones. The spacecraft contractor shall distribute an action item list arising during these teleconferences and track the status of these action items.

3.5.3.2 Documentation

1. The spacecraft contractor shall deliver documentation listed in the CDRL GND-3.5.2-01 through GND-3.5.2-06 for new GOES N-Q ground system elements.
2. For modified GOES I-M SSGS elements, the spacecraft contractor shall provide, in hard copy and electronic form, integrated change pages for the existing documentation or may provide complete, revised versions of the documents.
3. The spacecraft contractor shall supply required ground system documentation on electronic media and in hard copy form in compliance with the provisions set forth in the preparation of operation and maintenance manuals, NOAA/NESDIS Standard S24.801. Graphics embedded in documents and change pages shall also be provided as separate files in electronic form in a compatible graphics format (e.g., *wmf* for Word and *wpg* for WordPerfect documents).
4. The spacecraft contractor shall provide vendor operations, maintenance, and user documentation for all new commercial hardware and software products.

3.5.3.3 Training

1. As detailed in the CDRL GND-3.5.2-01 through GND-3.5.2-06, the spacecraft contractor shall provide training and training materials in conjunction with modified and new ground system elements as follows:
   a. User/Operator Training.
   b. Software Maintenance Training.
   c. Hardware Operation and Maintenance Training.
2. The spacecraft contractor shall conduct at least five training sessions per course in order to accommodate personnel on different work shifts at the SOCC, the Wallops CDA station (WCDAS), and the backup CDAS. The spacecraft contractor also shall provide two operations and maintenance training sessions at the SEC for the MDL receive system and archive. <u>The spacecraft contractor shall provide one operations and maintenance training session for the digital wideband tape recorder systems delivered at each site specified in paragraph 3.5.4.1, Item f.</u>

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3. Training classes and materials shall be developed in accordance with the General Requirements for Training on Electronic Equipment, NOAA/NESDIS Standard S24.804.
4. Training classes shall be completed three months before the launch of GOES-N, and shall be video taped for archive purposes.

3.5.4 SSGS Modifications

The spacecraft contractor shall modify, upgrade, or replace the GOES I-M Telemetry and Command System (GIMTACS) and the Orbit and Attitude Tracking System (OATS) to support the new and changed functions and capabilities of the as-built GOES N-Q spacecraft (backward compatibility of GOES N-Q software to support GOES I-M spacecraft is not required). As indicated in S-415-22, section 7.1.1, the replacement GIMTACS/PACS/IPACS workstations shall be reused. The spacecraft contractor shall provide new GOES N-Q Telemetry Acquisition and Command Transmission Systems (NTACTSs) and new MDL receive systems and archive to support the GOES N-Q spacecraft, as specified in S-415-22, sections 7.1.2 and 7.1.6. The SPSs and PMs shall be used as is, except for

changes required by the spacecraft contractor and approved by the government and those required to support the semi-annual spacecraft yaw flip maneuver. (Note: NOAA is pursuing the incorporation of yaw flip capabilities into the GOES I-M SSGS in response to the GOES-10 solar array anomaly. Under current planning these changes will be operational in February 1998.) The spacecraft contractor shall maintain the SPS data base containing the Imager and Sounder calibration and navigation constants measured by the instrument contractor, and shall also convert these calibration and navigation constants for use in the SPS.

3.5.4.1 Hardware

1. The spacecraft contractor shall design, develop, install, integrate, and test all new or modified ground system hardware needed for support of the as-built GOES N-Q spacecraft. On the assumption of client-server architectures and an overall SSGS architecture similar to GOES I-M, operational on-line and redundant quantities to be delivered are as follows (or equivalent quantities depending on the selected architecture):
   a. NTACTS - Five systems at the WCDAS and two at the backup CDAS.
   b. GTACS - As a minimum, 4 servers at the SOCC, 2 servers at the WCDAS, and 1 server at the backup CDAS (7 total). The spacecraft contractor shall increase these quantities, as needed, to meet redundancy requirements. Two encrypter/decrypters each plus a spare at the SOCC and the WCDAS, and 1 at the backup CDAS (7 total).
   c. MDL Receive System and **MPS Server**- Three receive systems, consisting of demodulat[1]ors, bit synchronizers and demultiplexing function, and 3 **MPS** servers each at the SOCC, the SEC, and the WCDAS, one receive system and **MPS** server at the backup CDAS (10 total), and any other additional hardware required to correctly receive, demodulate, format **and archive** data for processing by the MPS **and DID**.
   d. OATS - Five (5) systems at the SOCC, 2 at the WCDAS, and 1 at the backup CDAS (8 total). If the existing OATS DEC Alpha workstations are reused, 2 GOES I-M OATS-compatible DEC Alpha workstations shall be delivered to SOCC.
   e. DEChub 900 MultiSwitch backplane chassis and modules, as required to support the GOES N-Q SSGS. For a 10BaseT solution, the spacecraft contractor can assume the following quantities. For other solutions, such as Fast Ethernet, the spacecraft contractor shall propose equivalent quantities. Coordination with the government will be required after contract award to determine the optimal configuration for support of the GOES N-Q spacecraft and to provide interfaces to the GOES I-M and PACS networks.
      1. For the SOCC: one DEChub 900 MultiSwitch backplane chassis with four power supply modules, three PORTswitch 900TP modules, two DECswitch 900EE bridge modules, one PORTswitch 900FP fiber optic repeater module, four external RouteAbout router modules, one external POWER-switch module.

Amendment 2: The SOW uses “MDL Receive System and Archive,” whereas the Specification refers to “MDL Receive System, MPS, and MPS Server.” To avoid confusion, your proposal should clearly indicate which of these items you are discussing. Note that the MDL Archive capability is a part of the MPS Server, as defined in the specification.

2. For the WCDAS and the CDAS: one DEChub 900 MultiSwitch backplane chassis, four power supply modules, two PORTswitch 900TP modules, one DECswitch 900EE bridge module, one PORTswitch 900FP fiber optic repeater module, three external RouteAbout router modules, one external POWER-switch module.

f. Digital wideband tape recorder (DWTR) systems – Two systems for the NOAA WCDAS, one for the SEC, two systems with tape changers for ITT at Fort Wayne, IN, and two systems with tape changers for use at HSC until delivery of the last N-Q satellite. DWTR systems configurations shall be as shown in table 3.5.4.1-1. A 180 – day warranty following acceptance of the DWTR system shall be provided.

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2. The spacecraft contractor shall perform all on-site work without disruption to ongoing GOES operations. Government-approved, temporary failovers to the Wallops CDAS or the backup CDAS and operations from either CDAS not impacting the delivery of GOES data products are not considered disruptions.
3. The spacecraft contractor shall supply spare parts for all delivered GOES N-Q SSGS hardware in accordance with NOAA/NESDIS Standard S24.805, "Spare Parts." On-the-shelf spare requirements are above and beyond the quantities specified in section 3.5.2.1 item 1a.
4. The spacecraft contractor shall be responsible for maintenance of all GOES N-Q hardware from acquisition until formal acceptance by the government.
5. The spacecraft contractor shall deliver all hardware diagnostics applicable to delivered hardware components.

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Table 3.5.4.1-1 DWTR Systems Configurations

OPTIONS	HSC	ITT	SEC	WCDAS
Base Units	2	2	1	2
4-Channel U/G	2	0	0	0
DLT Drive U/G	0	0	1	2
DLT Changer U/G	2	2	0	0
Fail-soft Disk U/G	2	2	1	2
Bandwidth U/G	0	0	0	0
Installation	2	2	1	2

3.5.4.2 Software

1. The spacecraft contractor shall design, develop, install, integrate, and test all new GOES N-Q and modified/upgraded GOES I-M SSGS software.
2. The spacecraft contractor shall perform all on-site work without disruption to ongoing GOES operations. Government-approved, temporary failovers to the Wallops CDAS or the backup CDAS and operations from either CDAS not impacting the delivery of GOES data products are not considered disruptions.
3. Delivered commercial software products shall be at the most recent, compatible revision level (nominally three to six months) as of the date of the ground system final acceptance test, mutually agreed upon by the spacecraft contractor and the government. Where the most current software version is not used in the final acceptance test, the latest version shall be required for final acceptance unless an earlier version is acceptable to the government.
4. The spacecraft contractor shall be responsible for assuring compatibility of all delivered software with the as-built final configuration of the GOES N-Q hardware and software.
5. The spacecraft contractor shall be responsible for maintenance of all software developed under the contract until formal acceptance by the government, which is to occur no sooner than 9 months following the launch of GOES-N. The same shall apply for each subsequent spacecraft for every SSGS element requiring software changes.
6. Commercial software products shall be delivered with up-to-date valid perpetual licenses. A sufficient number of these licenses shall be provided to allow installation on all operational and spare machines for the ground system element using that software.
7. The spacecraft contractor shall validate and deliver copies of all databases required for use with the GOES N-Q spacecraft contractor, as stipulated in the CDRL GND-3.5.2-01 through GND-3.5.2-06. In addition, the spacecraft contractor shall also deliver any software tools required to develop, modify, and import databases into the GOES N-Q SSGS.
8. The spacecraft contractor shall deliver copies of all contractor-developed GOES N-Q SSGS source, object, and executable software, as per the CDRL GND-3.5.2-01 through GND-3.5.2-04, and GND-3.5.2-06. COTS software is excluded from the source and object code delivery requirement.
9. The spacecraft contractor shall deliver, with up-to-date valid licenses, two copies of each compiler needed for development and maintenance of spacecraft contractor-developed GOES N-Q SSGS software. For commercial products requiring special development licenses, two such licenses shall be provided.
10. The spacecraft contractor shall validate and deliver copies of all test and diagnostic software developed for troubleshooting, test verification, and analysis in support of spacecraft and instrument-to-ground system compatibility, as per the CDRL GND-3.5.2-01 through GND-3.5.2-06.
11. <u>The spacecraft contractr shall deliver up-to-date valid perpetual licenses and source code (COTS software is excluded) for the Digital Wideband tape Recorder System.</u> CCR4135C Mod28

3.5.5 Integration, Verification and Test

As per the CDRL GND-3.5.2-01 through GND-3.5.2-04 and GND-3.5.2-01, the spacecraft contractor shall provide test plans for verifying all new and modified elements at the unit level and after integration into the SSGS. For all system level tests, the spacecraft contractor shall provide any simulated or test data required to support the testing. Test plans shall include both functional level testing and operational tests where all expected on-orbit functions are verified. The system level tests will be conducted by the government with full contractor participation. This participation shall include witnessing of the tests and responsibility for resolving

test anomalies involving the new or modified SSGS elements. The spacecraft contractor shall publish an acceptance test report documenting via test results that all new or modified SSGS elements meet all requirements.

1. The spacecraft contractor shall verify functionality and performance of all new ground system elements and demonstrate complete compatibility with all interfaced equipment via the following test sequence:
   a. Proof-of-Concept Demonstration - informal demonstration of a new system during intermediate stages of development.
   b. Pre-shipment Test - formal test of a new system developed at a spacecraft contractor facility prior to installation at the government facility.
   c. Post-shipment Verification - test to ensure hardware integrity following shipment from the spacecraft contractor facility.
   d. Preliminary Acceptance Test - formal test to demonstrate functionality and performance of a new ground system element with all on-site interfaced equipment.
2. The spacecraft contractor shall provide on-site ground system hardware/software engineering support for the following joint contractor/government series of ground system integration, compatibility, operations, and acceptance tests once all modified and new systems are in place:
   a. Integrated Ground System Test - formal test demonstrating compatibility among all interfaced ground system elements. Test duration is approximately 10 days.
   b. Ground System/Spacecraft Compatibility Test - formal test demonstrating ground system compatibility with spacecraft data, formats, and timing. Also, test spacecraft/ground system calibration and alignment compatibility. The fully assembled spacecraft is not required, recorded spacecraft data may be used. Test duration is approximately 10 days, not necessarily contiguous.
   c. Parallel Operations Test - for GOES I-M shared elements, demonstration of full operational and contingency capabilities over a 30-day period.
   d. Final Acceptance Test - formal test after completion of all modifications/corrections to demonstrate ground system compliance with all requirements leading to system acceptance by the government. Test duration is approximately 10 days.
3. The government shall identify discrepancies during each test phase via GOES incident reports (GIRs) managed through the NOAA Anomaly Tracking System (ATS). The government shall identify from each test those GIRs to be resolved by the spacecraft contractor before proceeding to a subsequent test phase. The spacecraft contractor shall resolve all discrepancies from all test phases, and shall deliver and integrate appropriate hardware and software changes prior to beginning the final acceptance test.
4. (Deleted)

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3.6 Flight Operations

The spacecraft contractor shall provide engineering, documentation, training, and personnel support to NASA/GOES Operations Manager (GOM) in the preparation and execution of GOES N-Q flight operations. NASA will make available all interfaces, including voice, data, and communications defined by the spacecraft contractor for pre-launch tests, orbit-raising operations, post-launch tests, and on-orbit operations requiring coordination between the government operations center and the DSN ground stations—Goldstone, Canberra, and Madrid. These interfaces shall be available for pre-launch testing no later than March 1, 2001.

3.6.1 Management

The spacecraft contractor shall establish a flight operations office that provides overall mission operations management for all mission phases described in S-415-22, section 1.1. The spacecraft contractor's flight operations office effort shall begin with the design and development of spacecraft subsystems, and shall continue through the mission life of GOES N-Q spacecraft. The office shall be responsible for coordination of personnel, facilities, services and materials necessary during each mission phase. This includes, but is not limited to, launch support, development, test and delivery of databases, management of on-orbit anomaly investigations, management of sustaining engineering functions, and other support to NASA and spacecraft contractor's mission operations teams. The office also shall be the spacecraft contractor's focal point for mission operations activities between spacecraft launches, supporting routine activities, CDRL updates, anomaly investigations, etc. The spacecraft contractor shall provide a mission operations plan which provides all details of how mission operations will be supported throughout the mission as defined in CDRL OPS-3.6.1-03

3.6.1.1 Reviews

Flight operations reviews are defined in section 1.1, Program Reviews.

3.6.1.2 Documentation

The spacecraft contractor shall provide all personnel, services, and materials required to develop, review, and deliver all mission operations-related documents as defined in the CDRL. The GFE instrument contractor shall deliver mission operations-relevant instrument documentation to the spacecraft contractor. The spacecraft contractor shall then incorporate this information in the appropriate spacecraft CDRLs. Deliverable databases (e.g., telemetry definitions and formats, commands and command formats, calibration coefficients, etc.) shall be provided to support end-to-end testing and final versions will be provided three months prior to launch. Electronic copies of these databases shall be provided, and these databases shall be directly accessed by the ground system with no need for pre-processing or reformatting of any kind. The spacecraft contractor shall provide on-site support at applicable NASA and NOAA facilities for population and test of these databases for GOES N-Q. The spacecraft contractor shall provide on-site support for any updates/upgrades to ground based algorithms or databases for GOES N-Q through PLT for each spacecraft. The spacecraft contractor shall be responsible for performing routine maintenance and providing NASA with regular updates to all volumes of the spacecraft operations handbook as defined in CDRL OPS-3.6.1-01.

3.6.1.3 Documentation Reviews

The spacecraft contractor shall provide all personnel, services, and materials required to review a variety of operations-related documentation. These shall include, but not be limited to, operations scripts, spacecraft command procedures, contingency operations procedures, and operations handbooks.

3.6.2 Pre-launch Support (PREL)

3.6.2.1 Network Compatibility Testing and Data Flows

The spacecraft contractor shall provide all personnel services and materials required to assure compatibility

with all segments of any ground systems to be used throughout the mission, as described below.

3.6.2.1.1 In-plant Compatibility Testing

Testing of the GOES-N spacecraft shall be conducted with a government-provided ground network (GN) compatibility test suite during spacecraft functional testing prior to spacecraft-level environmental testing. Testing with GOES-O,P,Q shall be required if changes are made to the telemetry and command systems of these spacecraft.

3.6.2.1.2 GN Compatibility Testing and Data Flows

A spacecraft engineering or flight model DSN transponder shall be used for testing at all GN sites prior to the launch of GOES-N, and for any spacecraft that has changes made to the transponders. The purpose of this test is to ensure launch and on-orbit stations are compatible with the spacecraft telemetry, command and ranging systems. If an engineering model is used, it shall be functionally identical to the spacecraft components.

3.6.2.1.3 Launch Base Compatibility Testing

The spacecraft contractor shall provide all personnel services, and materials required to support a series of network compatibility tests in preparation for the final spacecraft end-to-end (ETE) testing defined in section 3.6.2.3.2.5. These network tests are intended to incrementally verify components of the network that will be used to support command and telemetry data flow between the spacecraft and government operations center. The spacecraft contractor shall provide test time for the spacecraft while located at the appropriate launch base facility.

3.6.2.1.4 Ground Storage Data Flows

In the event of ground-based storage for any spacecraft, the spacecraft contractor shall support a ground storage data flow for each state-of-health test conducted for the spacecraft in accordance with the Ground Storage Plan (CDRL I&T-3.4.10-01). These data flows will consist of telemetry data from the spacecraft at the storage facility through the GN to the government operations center. The duration of each data flow will be consistent with the spacecraft test period.

3.6.2.2 NOAA Compatibility Testing

As new spacecraft of the GOES N-Q series are brought into service, compatibility with existing systems shall be demonstrated as described below.

3.6.2.2.1 GOES-N Three-spacecraft Compatibility

The spacecraft contractor shall supply all personnel, services and materials required to demonstrate at least six months prior to the launch of GOES-N that the GOES N-Q ground system can successfully operate the GOES-N spacecraft with no conflict for resources with the GOES I-M spacecraft.

3.6.2.2.2 GOES-O Three-spacecraft Compatibility

The spacecraft contractor shall supply all personnel, services and materials required to demonstrate at least six months prior to the launch of GOES-O that the GOES N-Q ground system can successfully operate the GOES-N and GOES-O spacecraft without conflict for resources either internally or against the GOES I-M system.

3.6.2.2.3 GOES-P Three-spacecraft Compatibility

The spacecraft contractor shall supply all personnel, services and materials required to demonstrate at least six months prior to the launch of GOES-P that the GOES N-Q ground system can successfully operate three spacecraft, two operational and a third undergoing PLT, with no resource conflicts.

3.6.2.3 End-to-End Compatibility Testing

The spacecraft contractor shall support a series of ETE compatibility tests conducted pre-launch for each spacecraft. The ETE tests are designed to: (1) validate spacecraft/instrument databases; (2) fully demonstrate operational compatibility among the spacecraft, the government operations center ground systems, and network elements; and (3) familiarize the operations team with each spacecraft. To this end, the desire is to utilize actual flight hardware to the maximum extent possible. The government realizes that some components may present risk if operated on the integrated spacecraft while in the contractor's facility. The contractor shall provide a list of those components which it deems unsafe to operate during end-to-end tests. The contractor shall also institute a review process through which components may be added and deleted from this list by either the contractor or the government. For any items on this list, the contractor may support the test with government-approved simulated or emulated components.

The ETE tests are tailored to different phases of the launch readiness preparations and spacecraft mission. To accomplish any given ETE test there are certain generic types of activities to be performed. These include:

1. Devise the test goals and requirements.
2. Schedule the test and coordinate resources.
3. Conduct all subsystem reviews of the commands, telemetry monitors, procedures, scripts, contingency plans, etc., to be used during the test.
4. Conduct a final script review approximately two weeks prior to each test to cover the test plan, procedures, scripts, and test support and coordination activities.
5. Execute the planned command procedures and generate supporting data products during the test.
6. Obtain and process all supporting data into a post-test report.
7. Present a technical review to disclose the results of the test. This review shall cover all tests. Anomalies, problems, lessons learned, future improvements to the testing, etc. shall be presented along with the rationale for the suggested improvements.

Depending on the task to be performed, the spacecraft contractor will have a performing role or a supporting role. The performing participant in a test bears all responsibility for the timely completion and success of the test. The performing party is expected coordinate usage of the resources of the supporting party. The supporting participant in a test provides review of plans, monitors actual testing, and assists in post-test reporting. It shall be assumed that when the contractor performs, the government supports; and when the government performs, the contractor supports.

Details of each end-to-end test are provided in sections 3.6.2.3.2.1 through 3.6.2.3.2.5. The spacecraft contractor's role in performing or supporting each of the above seven items for each ETE test are provided.

The spacecraft contractor shall provide: spacecraft test time while the spacecraft is located at the appropriate spacecraft contractor's facility, test technicians and engineers to support the test at the spacecraft contractor's facility, and necessary spacecraft test equipment and ground network interface equipment link up the spacecraft telemetry and command system with the government operations center. The government will provide the appropriate control center and ground systems, the on-orbit operations team, and scheduling of NASA/NOAA GN resources.

3.6.2.3.1 Initial ETE Testing with GOES-N - (TEST 1A)

The spacecraft contractor shall provide all personnel, services, and materials required to conduct an ETE test of the initial baseline of the telemetry and command databases, and nominal command procedures. This test shall be performed approximately 12 months prior to the Earliest Storage Date (ESD). This test shall also provide familiarization with new and changed ground system elements. The spacecraft contractor shall perform all seven activities listed in section 3.6.2.3.

3.6.2.3.2 Recurring ETE Test Program

For each spacecraft in the series, the spacecraft contractor shall plan, manage, and execute the following ETE tests:

3.6.2.3.2.1 Telemetry, Command and Procedure Baseline Validation (Test 1)

The spacecraft contractor shall provide all personnel, services, and materials required to conduct an ETE test of the initial baseline of the telemetry and command databases, nominal command procedures, and ground systems processing. This test shall be performed approximately 11 months prior to the Earliest Storage Date (EDS) for GOES-N and 9 months prior to the Earliest Storage Date (ESD) of GOES-O. This test shall be performed 14 months prior to the launch of GOES-P and -Q. The spacecraft contractor shall perform all seven activities listed in section 3.6.2.3.

3.6.2.3.2.2 PLT and Operations Telemetry, Command and Procedure Validation (Test 2)

The spacecraft contractor shall provide all personnel, services, and materials required to conduct an ETE test to demonstrate PLT and normal operations (OPS) command procedures, data archival and display, and ground systems processing. Command schedule generation, uplink, and execution shall be exercised. On-board software (RAM and/or ROM) will be thoroughly exercised during this test sequence. This test shall be conducted prior to spacecraft level thermal vacuum testing. The spacecraft contractor shall support items 1, 3, 4, 6, and 7 and shall perform items 2 and 5 as listed in section 3.6.2.3.

3.6.2.3.2.3 Thermal Vacuum Testing (Test 3)

The spacecraft contractor shall provide all personnel, services, and materials required to conduct an ETE test while the spacecraft is in thermal vacuum environment conditions. The spacecraft contractor shall support items 1 ,3 ,4, 6, and 7 and shall perform items 2 and 5 as listed in section 3.6.2.3. These items only apply to the end-to-end portion of thermal vacuum testing.

This test shall consist of three phases:

1. Thermal Vacuum Telemetry Data Flow - Spacecraft subsystem telemetry processing by the ground system will be validated during the extremes of environmental conditions performed as part of the thermal vacuum test program.
2. Instrument Data Validation Test - Spacecraft instrument command scenarios will be exercised during thermal vacuum testing. Tapes of instrument data shall be generated. These tapes will be subsequently processed at the government operations center ground system for verification and validation of specialized instrument data processing.
3. INR Validation Test - INR scenarios shall be exercised during thermal vacuum testing and tapes of instrument data shall be generated. The tests shall be designed to exercise the INR signals applied to the instruments and verify system performance of the spacecraft, instruments and ground system. The resulting tapes also will be processed at the government operations center ground system for verification and validation of specialized instrument data processing.

3.6.2.3.2.4 Final Procedure and Database Validation (Test 4)

The spacecraft contractor shall provide all personnel, services, and materials required to conduct an ETE test to demonstrate final LOR, PLT and normal operations nominal and contingency procedures (COPs). This test will confirm all modifications to command procedures and telemetry processing as a result of all lessons learned from prior ETE tests. Any required regression testing will be performed as well. This test shall occur after final thermal vacuum testing and before the shipment of the spacecraft to the launch site. The spacecraft contractor shall perform all seven activities listed in section 3.6.2.3.

3.6.2.3.2.5 Launch Base Final Operations Evaluation (Test 5)

The spacecraft contractor shall provide all personnel, services, and materials required to conduct a final telemetry data flow from the launch facility. This test will provide a final pre-launch verification of spacecraft subsystem telemetry processing at the government operations center. The spacecraft contractor shall perform all seven activities listed in section 3.6.2.3..

3.6.2.4 Mission Operations Simulations

The spacecraft contractor shall provide any personnel, services, and materials required to support a maximum of five training simulations for rehearsal of critical launch and on-orbit mission phases. This includes one dress rehearsal of the launch to separation sequence for each spacecraft, one nominal LOR simulation, one nominal operations simulation, and two simulations of contingencies during LOR, PLT, and normal operations phases. These simulations shall be supported by government participation. The DSN will be made available by the government for simulation purposes, if needed and requested.

3.6.2.4.1 Launch Network Countdown Simulations

The spacecraft at the launch base shall provide real-time telemetry to the government operations center on a non-interfering basis while it is in the payload processing facility and in a launch configuration,. The spacecraft shall provide real-time telemetry to the government operations center while it is on the launch pad and in a launch configuration in support of a final countdown launch simulation,

3.6.2.4.2 Pre-launch Spacecraft Data Flows

The spacecraft shall provide real-time telemetry to the government operations center on an as available basis during the final two weeks before launch. This includes telemetry flows to the government operations center while the final launch configuration is being set.

3.6.2.5 Procedure Development

The spacecraft contractor shall provide all personnel, services and materials required to develop all orbit raising procedures, including bus checkout procedures. The spacecraft contractor shall provide these procedures to NASA for final approval. NASA retains responsibility for, and execution of, GFE instrument procedures and activities. NASA also retains responsibility for development of all on-orbit operations procedures based on spacecraft contractor supplied outlines. NASA will provide all procedures to the spacecraft contractor for review.

3.6.2.5.1 Contingency Procedures

The spacecraft contractor shall provide all personnel, services, and materials required to create a complete set of contingency operations procedures (COPs) covering all spacecraft bus operations prior to the engineering handover, as described in following section 3.6.3.3. The spacecraft contractor shall also provide any personnel, services and materials required by NASA for the creation of on-orbit COPs. The spacecraft contractor shall provide new COP outlines required by any new hardware or software changes for GOES-

O,P,Q. COPs for GFE instruments shall be developed by NASA and incorporated into the spacecraft contractor-supplied COPs.

3.6.2.6 Training Program

The spacecraft contractor shall provide all personnel, services, and materials necessary to deliver and present a training program to the GOES N-Q government team, in accordance with CDRL OPS-3.6.1-02. The training shall be performed at a government furnished facility located near GSFC. The training program shall consist of not less than 120 hours of classroom training. The training shall consist of detailed subsystem analysis, including design and development overviews, detailed engineering drawing reviews, operations concepts, hardware/software interfaces, and a description of the resolution of all problems encountered in the subsystem development. The training shall also include interfaces with the ground system, and changes and/or upgrades that affect INR. All training presentations shall be videotaped for archival purposes.

GOES-N training shall be provided no later than 12 months before launch. For GOES O-Q, the training shall be abbreviated to include only baseline changes and unique features or problems encountered with the specific spacecraft. For GOES O-Q the training shall be provided no later that 6 months prior to launch.

The spacecraft contractor shall provide six mission operations training tools (spacecraft models 1/24 scale). CCR4142A, Mod 29

3.6.3 Launch and Orbit Raising (LOR) Support

The spacecraft contractor shall provide personnel, services, and materials required to perform launch preparations, launch support, orbit raising maneuvers, spacecraft appendage deployments, spacecraft bus and SEM instrument checkout, and support for NASA to perform GFE instrument operations. NASA has requirements for certain activities during the orbit raising phase as described in S-415-22, section 6.2.2. The spacecraft contractor shall provide a mission profile in accordance with CDRL OPS-3.6.1-01.

Orbit raising activities shall be conducted by the spacecraft contractor from a government operations center facility. NASA retains responsibility for all GFE instrument activities through engineering handover.

3.6.3.1 Engineering Support

The spacecraft contractor shall provide continuous engineering support during the LOR mission phase, i.e., from launch through engineering handover. This includes performing all monitoring and analysis functions, executing all orbital maneuvers, and deploying all spacecraft appendages. GFE instrument deployments shall be performed by NASA.

3.6.3.2 Spacecraft Checkout

The spacecraft contractor shall provide all personnel, services, and materials required to complete the orbit raising within 18 days and perform spacecraft bus checkout within 6 days thereafter.

3.6.3.3 Engineering Handover

The spacecraft contractor shall provide all personnel, services, and materials required to perform an engineering handover to NASA after spacecraft bus checkout, at Launch + 24 days, at which time NASA assumes responsibility for the health and safety of the spacecraft. The spacecraft contractor shall perform an engineering review to denote the completion of handover in accordance with CDRL OPS-3.6.3-01. The spacecraft contractor shall present an LOR data review within 5 weeks of this handover (L+2 months) in accordance with CDRL OPS-3.6.3-02.

In a non-nominal launch situation, the spacecraft contractor shall provide engineering and operations support until the engineering handover is accomplished.

3.6.4 Post-launch Test Support

PLT is the specification compliance determination phase of the mission, which will be performed by the government. This phase begins at engineering handover and is expected to be completed within 180 days for GOES N and 150 days for GOES O,P,Q. The completion of PLT marks spacecraft on-orbit delivery. No spacecraft shall be stored until after PLT is completed.

In general, tasks to be performed for ETEs in section 3.6.2.3 apply to PLTs. The exceptions are as follows:

1. Most tests in the PLT do not use scripts, although critical activities may require scripts and the appropriate preparations and reviews of section 3.6.2.3 item 4,
2. The PLT report is produced at the end of the PLT program, whereas ETE reports are generated after each test.
3. The PLT review may require more than one day.

With these exceptions noted, the spacecraft contractor shall support all items in 3.6.2.3 for PLT.

3.6.4.1 Engineering Support During Post-launch Test

The spacecraft contractor non-resident level-of-effort engineering support shall be provided for each subsystem through the completion of PLT for GOES N-Q in support of the NASA operations team.

The spacecraft contractor resident level-of-effort engineering support shall be provided for INR through the entire PLT phase for GOES N-Q, in support of the NASA INR team. Resident support shall also be required for the telemetry and command and communication system PLTs.

3.6.4.2 INR Post-launch Test Plan

The spacecraft contractor shall provide a post-launch INR test approach describing the tests to be performed by NASA to initialize and/or characterize INR in orbit (CDRL SE-2.4-01). The test plan shall provide recommendations for the intervals required between required calibration procedures, and recommendations for when the test should or could be done (e.g., seasonally, time of day). Test groups may be used in lieu of test plans for each required INR calibration and/or initialization procedure to provide a clear overview of the overall procedure; however, test groups should clearly indicate the individual tests required for each procedure. The test approach shall be provided with the proposal and updated for the PDR and CDR.

3.6.5 Operations Support (OPS)

The spacecraft contractor shall provide continuing engineering support, to the GOM and GOES program for the life of each GOES N-Q spacecraft, following its PLT phase, as detailed in the following sections.

3.6.5.1 Resident Engineering Support

The spacecraft contractor shall provide all personnel, services, and materials necessary to maintain a resident presence from 6 months prior to launch of GOES-N through the first 12 calendar months that GOES-O is on orbit. The amount of resident support should be commensurate with the planned activities during this time period. For the GOES-P and GOES-Q spacecraft this presence is required from 3 month prior to launch through the completion of the PLT phase for each spacecraft. Responsibilities shall include:

1. Attendance at NASA operations meetings and reviews.
2. Interface with the spacecraft contractor's program office.
3. Participation in GOES Incident Report (GIR) screening boards,
4. Real-time support for all critical activities performed by NASA during PLT
5. General assistance in:
    a. Performing engineering investigations and studies.
    b. Resolving anomalies (see 3.6.5.3).
    c. Implementing data base updates(see 3.6.5.4).
    d. Coordinating trending activities and monitoring.
    e. Assisting in the preparation of the PLT Report and Data Review Package

3.6.5.2 Spacecraft Storage Support

For the first spacecraft of the GOES N-Q series to be placed into storage mode, the contractor shall provide all personnel, services, and materials necessary to support systems, power, thermal, and attitude control engineering for a period of 30 days from the time of entry into storage. For the first spacecraft of the GOES N-Q series to be recalled from storage, the spacecraft contractor shall supply systems, power, thermal, attitude control and INR support, for a period of 30 days from the time of exit from storage. All necessary storage operations and contractor support to be provided shall be defined in the CDRL OPS-3.6.2-01.

3.6.5.3 Anomaly Resolution Support

The spacecraft contractor shall provide all personnel, services, and materials necessary to resolve anomalous behavior of the spacecraft as described below:

3.6.5.3.1 Out-of-specification Performance

The spacecraft contractor shall resolve out-of-specification on-orbit performance issues as assigned to the contractor by the NASA/GOES program GIR Screening Board. This support shall remain effective until the specified mission end-of-life of the last GOES N-Q spacecraft. This includes support of periodic conference calls on the status of GIRs under investigation.

3.6.5.3.2 Non-specified Performance

The spacecraft contractor shall perform on-orbit task assignments as authorized by NASA in accordance with contract clause C.2. These assignments shall pertain to out-of-family but in-specification, and non-specified performance. Each task will be initiated by written direction from the NASA contracting officer, and shall be coordinated with the spacecraft contractor, a priori, to define the details of the task, its manpower ceiling, and scheduling requirements.

3.6.5.4 Spacecraft Database Support

The spacecraft contractor shall provide all personnel, services, and materials necessary to correct all discrepancies discovered in the contractor-delivered set of databases, by the contractor, for each spacecraft until its end-of-life. The contractor shall also maintain a current set of databases reflecting all changes made by the government and used in the current mission.

3.6.5.5 Spacecraft De-orbit Plan

The spacecraft contractor shall prepare and provide a recommended spacecraft de-orbit plan as described in CDRL OPS-3.6.2-02

3.7 Mission Assurance (MA)

The GOES N-Q spacecraft mission assurance (MA) program shall be commensurate with the mission and performance requirements of this document and S-415-22. It shall ensure that both lifetime and performance requirements are met by the flight and ground hardware and software. The spacecraft contractor shall document the MA program, including its procedures, processes, and related metrics, as well as its management and coordination with NASA MA personnel. In addition to the basic quality management system defined by the elements of ASQC/ANSI Q9001-1994, the spacecraft contractor shall utilize advanced quality practices, including appropriate metrics, that will further reduce program risk. Following contract award, the spacecraft contractor shall provide to NASA spacecraft contractor changes to the MA program prior to their implementation.

The spacecraft contractor*s work activities, operations, and documentation shall be subject to review and evaluation for conformance to their documented MA program and ASQC/ANSI Q9001-1994 by NASA representatives at their facilities and other locations (e.g., spacecraft contractor facilities, pre-launch testing facilities, vendor facilities) in accordance with a Project Surveillance Plan to be written by NASA in coordination with the spacecraft contractor; the details of this plan will be finalized after contract award. The spacecraft contractor shall provide to NASA representatives in-plant access to documentation and information related to MA activities, including those related to: system safety, parts, materials and process, reliability analyses, printed wiring board coupons/analysis reports, and Failure Review Board (FRB) and Material Review Board (MRB) activities and reports.

3.7.1 Flight Heritage and Previously Qualified Hardware and Software

The spacecraft contractor is encouraged to incorporate flight heritage hardware and software into the GOES N-Q design to the fullest extent possible. The spacecraft contractor may propose to eliminate some program

tasks based on the use of previously qualified hardware and/or software for this program. All such tasks shall be clearly identified in the contractor*s previously qualified hardware and software report (CDRL PA-3.7.1-02). That detailed report is the spacecraft contractor*s vehicle for justifying assertions that hardware components or subsystems and software modules or programs have been previously qualified. The spacecraft contractor shall demonstrate that the hardware or software has previously demonstrated the capability of meeting the GOES N-Q spacecraft mission, lifetime, performance, and MA requirements. However, NASA must concur with each task elimination.

3.7.1.1 Flight Heritage/Previously Qualified Software

Flight heritage/previously qualified software shall be defined, without exception, as software that the spacecraft contractor developed/purchased, documented, tested, and qualified at a level equal to or higher than that required for the GOES N-Q program. The software shall meet the functional, performance, reliability, and interface requirements of the GOES N-Q program without any modification. The spacecraft contractor shall be responsible for ensuring that the software conforms to the GOES N-Q software management and development requirements specification, including requirements for design, coding and documentation. If not, the spacecraft contractor shall be responsible for securing a GSFC project waiver to those standards. To substantiate heritage in order to eliminate program tasks, the spacecraft contractor shall verify that the software proposed for use on the GOES N-Q program is in every way identical to the software which was previously qualified. This includes, but is not limited to:

1. Design specifications
2. Design, MA, and interface requirements
3. Application
4. Vendor and revision level
5. Lower level testing up to and through the software level for which heritage is claimed
6. Deviations/waivers.

3.7.1.2 Flight Heritage/Previously Qualified Hardware

Flight heritage/previously qualified hardware shall be defined, without exception, as hardware that the spacecraft contractor developed/purchased, documented, tested, and qualified at a level equal to or higher than that required for the GOES N-Q program. The hardware must meet the functional, performance, quality, reliability, and lifetime requirements of the GOES N-Q program without any modification. The contractor shall be responsible for ensuring that the hardware conforms to the GOES N-Q program performance, mission, and lifetime requirements. To substantiate heritage in order to eliminate program tasks, the spacecraft contractor shall verify that the hardware proposed for use on the GOES N-Q program is in every way identical to the hardware which was previously qualified. This includes, but is not limited to:

1. Design specifications
2. Design, environmental, MA, and interface requirements
3. Application
4. Vendor/manufacturer and manufacturing facility
5. Components, parts, materials, and processes
6. Lower level/component testing up to and through the hardware level for which heritage is claimed

7. Deviations/waivers.

3.7.2 System Safety Program

For the GOES N-Q spacecraft with contractor-provided launch vehicle/services, NASA will audit the system safety program for those spacecraft and launch vehicles; and the spacecraft contractor shall interface directly with the Eastern Test Range (ETR) system safety personnel. However, the spacecraft contractor shall not be relieved from the requirement to have a system safety program fully compliant with EWR 127-1.

3.8 Launch Vehicle/Services and Related Activities

3.8.1 General

CDRLs and documentation requested by NASA that are launch services proprietary may be submitted directly to NASA. This will not relieve the spacecraft contractor of their launch services responsibilities.

3.8.1.1 Definitions

For the purpose of this SOW, the following definitions apply:

1. Launch Vehicle (LV): all flight hardware and software, with the exception of the spacecraft hardware, that is required to deliver the spacecraft to the specified orbit/trajectory.
2. Launch Vehicle System (LVS): the LV plus all launch site facilities, equipment, and software required to process the LV, perform pre-launch checkout, launch countdown, launch, and in-flight tracking and telemetry data retrieval.
3. Launch Service (LS): all services required to successfully deliver the GOES spacecraft into the required orbit/trajectory. This includes the design, development, qualification, production, assembly, integration, testing, analyses, modification, maintenance, and operation of the LVS. Also included are mission unique/peculiar services, mission integration analyses, all materials, propellants, gases, support services, and personnel to integrate the spacecraft with the LVS and conduct each launch.
4. Mission Unique/Peculiar Services (MUPS): the mission unique hardware and services that are available to support specific mission or spacecraft requirements as either an alternate to the standard service, or providing an extended capability beyond the standard service but within the existing LVS capability.

3.8.2 Contractor Provided

The spacecraft contractor shall provide all personnel and services to procure and provide the launch vehicle/services and related activities required to deliver the GOES N-Q spacecraft to the specified orbit/trajectory. This shall include:

1. Providing the management to assure the launch services conform with contract requirements.
2. Performing all required studies and assessments.
3. Obtaining all licenses, permits, and approvals.
4. Providing for appropriate NASA insight and approval.
5. CDRLs LV-3.8-01 through LV-3.8-26.

The spacecraft contractor shall provide a blue and white U.S. Department of Commerce NOAA logo replica that shall be attached to each launch vehicle and be prominently visible from 500 feet.

3.8.2.1 Mission Integration

The spacecraft contractor shall provide mission integration management for all activities associated with spacecraft to launch vehicle/services integration. This includes: systems integration, interface definitions, interface verification, spacecraft to launch vehicle integration, ground processing facilities and GSE integration/readiness, and launch support effort. The spacecraft contractor shall be responsible for assuring that compatible interfaces between hardware and software are defined, coordinating spacecraft launch vehicle interface requirements definitions, and supporting and/or conducting design and safety reviews, Technical Interchange Meetings (TIMs), and working group and ad-hoc meetings. The spacecraft contractor shall be responsible for the development of interface documentation and ensuring that all requirements have been satisfactorily implemented.

The spacecraft contractor shall perform configuration management and maintain configurations per requirements of the ICD. The spacecraft contractor shall perform all mission unique integration analyses required to verify compatibility of the spacecraft design with the launch vehicle interfaces and environments. The spacecraft contractor shall be responsible for providing the mission unique flight, ground simulation, and checkout software necessary to perform each mission. Analysis data shall be provided per CDRLs LV-3.8-02 and LV-3.8-03 (Preliminary and Final Mission Analysis Reports).

3.8.2.2 Launch Services Systems Effectiveness (LSSE)

The spacecraft contractor shall provide an LSSE Program Plan in accordance with CDRL LV-3.8-08. The LSSE Program Plan may exactly reflect one currently in use by the launch vehicle contractor. The spacecraft contractor shall provide any changes to the LSSE Program Plan to NASA prior to its becoming effective.

The LSSE function shall provide a point of contact for NASA for LSSE Program activities.

The spacecraft contractor shall provide overall audit plans and schedules to NASA, and update schedules for in-house and subcontractor audits, as required. The spacecraft contractor shall provide their reports on in-house and subcontractor audits to NASA.

Also, NASA shall be part of any audit team and will monitor audit activities, but will not exercise approval of activities. The spacecraft contractor shall accommodate NASA participation in audits of in-house efforts, of major subcontractors, and of suppliers. Items audited that shall have NASA participation include product quality, workmanship, and processes.

3.8.2.3 NASA Insight

3.8.2.3.1 Launch Vehicle-related Program Reviews

The spacecraft contractor shall provide NASA insight into the development of the launch vehicle/services and related activities. The spacecraft contractor shall arrange for NASA to attend, co-chair, and participate in the launch-related (vehicle and integrated spacecraft/launch vehicle) reviews defined in section 1.1.

3.8.2.3.2 Systems Development/Modifications and Mission Unique/Peculiar Design

The spacecraft contractor shall require that the launch services supplier provide insight into the qualification of new, modified, or unqualified components, systems, software, and new or modified structures, including GSE when different from those previously used. The spacecraft contractor shall ensure that NASA shall be provided insight for all modifications to assure that the analyses, designs, production, qualification testing, and mission assurance practices result in the maximum practical probability of mission success.

The spacecraft contractor shall require that the launch services supplier design, qualify, manufacture, test, and install all required LVS mission unique ground and flight MGSE and EGSE. In addition, the spacecraft contractor shall be responsible for providing the mission unique flight, ground, simulation, and checkout software necessary to perform the mission.

3.8.2.3.3 NASA Insight into Launch Site Services

In support of each launch, the spacecraft contractor shall provide NASA insight into the following areas:

1. The supplies and services required to modify, validate, operate, maintain, and refurbish the launch site facilities, hardware, and GSE.
2. The required approvals/waivers and any tailoring of launch range safety requirements that may be proposed in order to meet the intent of EWR 127-1 (March 31, 1995).
3. All ground and flight constraints.
4. Launch site operations schedules and daily updates, as required, for the time period from LV on stand through launch, including NASA participation in vehicle walk-down inspections.
5. All identified tests, checkouts, and closeout data to assure successful integration of the spacecraft to the launch vehicle, and launch.
6. Problem/discrepancy reports, anomalies, failure analyses, and post-test data including all problem resolutions, closure actions, and deviations/waivers.

3.8.2.3.4 Flight Failure/Anomaly Investigation

The spacecraft contractor shall investigate and resolve all LVS anomalies and failures. As a part of NASA's insight, the spacecraft contractor shall notify NASA of meetings related to failures and/or anomalies involving similar launch vehicles and subassemblies/components, and shall permit NASA personnel to participate in these meetings. In addition, the spacecraft contractor shall ensure that any launch vehicle-related problem reports or discrepancy reports are made available to NASA upon request. This shall include insight into LV fleet-wide problems, anomalies, MRB actions, and any deviations or waivers to systems, subsystems, materials, processes, test instruments and non-NASA launch vehicle operations.

3.8.2.3.5 Data and Documentation

The spacecraft contractor shall provide for the acquisition of data and documentation, and shall provide support services, as necessary, to permit NASA to accomplish meaningful insight and oversight.

The spacecraft contractor shall define and maintain a list of specifications and requirements documents for the LVS design, manufacturing, and I&T. The spacecraft contractor shall provide to NASA waivers and deviations to the specifications and requirements. Relevant supplemental documentation shall be made available to NASA upon request.

3.8.2.4 NASA Resident Office for Launch Vehicles

3.8.2.4.1 NASA Resident Office Facility

The spacecraft contractor shall arrange for NASA to have a GOES N-Q resident office at the launch vehicle contractor's facility through the launch of the last spacecraft in the GOES N-Q series on a contractor-furnished launch vehicle. This office shall have space, furniture, copier(s), and telephones for 10 people.

3.8.2.4.2 NASA Resident Office Responsibilities and Required Support

NASA Resident Office personnel will be responsible for exercising the insight and, through the Contracting Officer, the approval provisions. Resident office personnel and supporting technical personnel will review and evaluate LVS activities, including analyses, designs, production, testing and operations related to the core vehicle, and mission peculiar/unique items related to each mission. The spacecraft contractor shall provide the following information on the core vehicles and MUPS items:

1. Quality Assurance Reports (QARs) or equivalent
2. Problem Reports (Prs) or equivalent
3. Space Program Reliability Board (SPRB) Minutes or equivalent
4. Engineering Review Board (ERB) Minutes or equivalent
5. Material Review Board (MRB) Minutes or equivalent

The above information shall be provided either through access to the QA on-line data system, via electronic mail, or via distribution.

As part of NASA's insight role, inspection of the assigned vehicle will be performed as required through various phases of its assembly, up through final closeout prior to launch. To support this, the spacecraft contractor shall provide sufficient access to the vehicle, externally and internally, to ascertain the flight worthiness and correct configuration of the vehicle. Specific insight role activities include the following:

1. Attend contractor meetings such as space program reliability board, space parts control board, engineering review boards, and test status meetings.
2. Have access to applicable documentation such as corrective action problem summary, anomaly reports, discrepancy reports, engineering change notices, and test reports.
3. Receive status reports, to include existing master program schedule and production schedules.
4. Review procedures and deviations and monitor the LVS testing prior to spacecraft mate (wet dress rehearsal and simulated flight test).
5. Review procedures and deviations and monitor major vehicle system tests (e.g., main engine leak tests, flight control functional tests).
6. Participate in integrated spacecraft and LV testing by reviewing procedures and deviations, and observing actual tests, such as encapsulation, spacecraft mate, CERT, and launch countdown.

7. Review data from above tests.
8. Have access to all anomaly resolution activities.
9. Attend daily status and schedule meetings at the launch site.

3.8.2.5 Independent Assessment Support

NASA reserves the right to have independent assessments performed of mission unique analyses and software functions. Specific areas in which NASA may elect to have independent assessments performed are: coupled loads analyses, control and stability analyses, trajectory and performance analyses and software development and verification. The spacecraft contractor shall support these assessments by providing analytic models, model documentation, input data, and analysis results. The models, documentation, analysis results, and input data shall be provided in the forms normally generated. The independent assessments shall not replace IV&V activities provided by the spacecraft contractor.

3.8.2.6 Launch Commit Criteria

NASA shall be part of the launch countdown polls, including the go/no-go launch decision. To support NASA's participation in the launch countdown polls, the spacecraft contractor shall provide spacecraft and launch vehicle telemetry at the NASA Mission Director's Center (MDC) at the Cape Canaveral Air Force Station for monitoring by NASA engineering teams. The spacecraft contractor shall provide all support (data flows), materials (data tapes), and equipment necessary to ensure the interface to the NASA MDC telemetry laboratory is ready to support these launch activities.

The spacecraft contractor shall provide a launch vehicle launch commit criteria in accordance with CDRL LV-3.8-22.

3.8.2.7 Post Launch

The spacecraft contractor shall provide a launch vehicle post-launch report in accordance with CDRL LV-3.8-26.

3.8.3 Clause H.10, Government Provided Launch Services

If clause H.10 is invoked, then this section and its subsections shall be used in lieu of section 3.8.2 and its subsections. Also, CDRLs LV-3.8-01 through LV-3.8-05 and LV-3.8-09 through LV-3.8-26 are not required for any spacecraft/launch vehicle mission when Clause H.10 is invoked. This section shall not take effect unless and until the government elects to provide launch services for any spacecraft under this contract.

Government-provided launch services shall include:

1. Launch vehicle.
2. Payload processing and spacecraft fueling facility, including existing facility systems, equipment, and communication networks.
3. Launch vehicle telemetry coverage for the launch phase.

3.8.3.1 Mission Integration Support for Launch Services

The spacecraft contractor shall provide management and engineering support for all spacecraft activities associated with the launch vehicle/services. This includes: systems integration, interface definitions, interface verification, spacecraft to launch vehicle integration, ground processing facilities and GSE integration/readiness, and launch support effort. The spacecraft contractor shall be responsible for assuring that compatible interfaces between hardware and software are defined, coordinating launch vehicle interface requirements definitions, and supporting and/or conducting design and safety reviews, Technical Interchange Meetings (TIMs), and working group and ad-hoc meetings. The spacecraft contractor shall support all activities related to the development of interface documentation and provide concurrence that all requirements have been satisfactorily implemented by the government-provided launch services contractor.

3.8.3.2 Analytic and Test Support for Launch Services

The spacecraft contractor shall provide management and engineering support for all analytic efforts conducted by the government-provided launch services contractor necessary for the assessment of launch vehicle environments, interfaces, and ground processing on the spacecraft design. This support includes development of detailed spacecraft analytic models, analysis of alternate interface accommodations and changes in environments as a result of additional flight data or other launch vehicle design changes, analysis of ground processing facility compatibility, compliance with interface safety requirements, and compatibility with launch vehicle flight environments and flight design. In addition, the spacecraft contractor shall support any tests (e.g., fit checks, shock tests) as required to ensure that spacecraft requirements are satisfied.

3.8.3.3 Interface Compatibility Support for Launch Services

The spacecraft contractor shall perform interface compatibility testing in accordance with CDRL LV- 3.8-06 to ensure all hardware, software, operational interfaces, and environments are compatible with the spacecraft design.

3.8.3.4 Launch Processing Support for Launch Services

The spacecraft contractor shall provide management and engineering support for NASA-provided launch services launch operations and planning. This support shall cover all spacecraft standalone and integrated operations with the launch vehicle, starting with spacecraft encapsulation through spacecraft separation and post-separation maneuvers. In addition, this support shall include the development of spacecraft launch vehicle integration test plans, procedures, and services; checkout of interfaces with the launch vehicle and launch facilities; and end-to-end tests involving the spacecraft, launch vehicle, and ground system.

3.9 Government Operations Center

3.9.1 Government-furnished Operations Center

NASA will supply the control center from which spacecraft-related launch and orbit raising, and some or all of PLT will be performed. This control center will have, as a minimum, the capabilities found in the control center currently in use in Suitland, MD. The resources include terminals, voice and data lines, and physical facilities of similar quantity and quality to that used for GOES I-M. Additional equipment required by the contractor to support launch and orbit raising shall be the responsibility of the spacecraft contractor. The type(s) and amount(s) of additional equipment and support required shall be coordinated with NASA.

3.9.2 Transition From Government Operations Center to SOCC

The contractor's design shall provide for a transparent transition of operations from the Government-furnished Operations Center to the Satellite Operations Control Center (SOCC) at any time following handover at geosynchronous orbit, but before the end of PLT.